# OPERATION AND SERVICE MANUAL

# FREQUENCY STANDARD

# MODEL 5B

SERIAL NO. S-69012

September 1967

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TRACOR, Inc.

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# INTRODUCTION

This manual contains the information necessary to operate and maintain the Frequency Standard Model 5B manufactured by Sulzer Laboratories Division, TRACOR, Inc. This information includes physical description, installation procedures, operating procedures, theory of operation, procedures for calibration and alignment, a parts list, and applicable drawings and diagrams required to provide adequate manual support.

This manual is to be used by all personnel operating or servicing the Frequency Standard.

Appendix A contains the operation and service manual for the Power Supply Model 5P. The Power Supply Model 5P is optional equipment supplied on customer request only.

TABLE OF CONTENTS


| Section | | | Page |
|---|---|---|---|
| I | GENERAL DESCRIPTION | | 1-1 |
| | 1-1 | Scope of Section | 1-1 |
| | 1-3 | Purpose of Equipment | 1-1 |
| | 1-5 | Description of Equipment | 1-1 |
| | 1-7 | Electrical Specifications | 1-1 |
| | 1-9 | Output Requirements | 1-1 |
| | 1-14 | Power Requirements | 1-6 |
| II | INSTALLATION | | 2-1 |
| | 2-1 | Scope of Section | 2-1 |
| | 2-3 | Installation | 2-1 |
| | 2-5 | Rack Mounting | 2-1 |
| | 2-7 | Optional Mounting Method | 2-3 |
| | 2-9 | Power Connections | 2-3 |
| III | OPERATION | | 3-1 |
| | 3-1 | Scope of Section | 3-1 |
| | 3-3 | Equipment Turn On | 3-1 |
| | 3-5 | Electrical Tuning Operation | 3-2 |
| IV | THEORY OF OPERATION | | 4-1 |
| | 4-1 | Scope of Section | 4-1 |
| | 4-3 | Functional Analysis | 4-1 |
| | 4-5 | DC Power Regulating Section | 4-1 |
| | 4-6 | Frequency Control Section | 4-1 |
| | 4-8 | Temperature Control Section | 4-3 |
| | 4-11 | Detailed Theory of Operation | 4-4 |
| | 4-13 | 5 MHz Oscillator | 4-4 |
| | 4-14 | AVC Amplifier | 4-4 |
| | 4-16 | Buffer Amplifier | 4-5 |
| | 4-17 | Frequency Divider | 4-5 |
| | 4-22 | Tuned Amplifier | 4-7 |
| | 4-24 | DC Voltage Regulator and Filter | 4-7 |
| | 4-27 | Oven Temperature Controller | 4-8 |

TABLE OF CONTENTS (Continued)


| Section | | Page |
|---|---|---|
| V | MAINTNEANCE | 5-1 |
| | 5-1 Scope of Section | 5-1 |
| | 5-3 Test Equipment Required | 5-1 |
| | 5-5 Trouble Analysis | 5-1 |
| | 5-7 Calibration | 5-1 |
| | 5-9 Frequency Adjustment | 5-2 |
| | 5-15 Tuned Transformer Alignment | 5-5 |
| VI | REPLACEABLE PARTS | 6-1 |
| | 6-1 Scope of Section | 6-1 |
| | 6-3 List of Replaceable Parts | 6-1 |
| | 6-5 Reference Designation | 6-1 |
| | 6-6 Part Description | 6-1 |
| | 6-7 Sulzer Laboratories Stock Number | 6-1 |
| | 6-8 Federal Supply Code for Manufacturers | 6-1 |
| | 6-11 Ordering Information | 6-2 |
| VII | DRAWINGS AND DIAGRAMS | 7-1 |
| | 7-1 Scope of Section | 7-1 |
| APPENDIX | | |
| A | SULZER LABORATORIES POWER SUPPLY MODEL 5P OPERATION AND SERVICE MANUAL | A-1 |
| | A-1 Introduction | A-1 |


LIST OF ILLUSTRATIONS


| Figure | Title | Page |
|---|---|---|
| 1-1 | Frequency Standard Model 5B | 1-2 |
| 1-2 | Rack Mounted Frequency Standard with Power Supply | 1-3 |
| 2-1 | Rack Panel Mounting Template | 2-2 |
| 2-2 | Frequency Standard Center of Gravity | 2-3 |

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## LIST OF ILLUSTRATIONS (Continued)


| Figure | Title | Page |
|---|---|---|
| 4-1 | Frequency Standard Functional Block Diagram... | 4-2 |
| 4-2 | Divide-By-Five Divider Functional Block Diagram..... | 4-6 |
| 4-3 | Inner Oven Temperature Controller Functional Block Diagram..... | 4-9 |
| 7-1 | Frequency Standard Schematic Diagram S-69001..... | 7-3 |
| 7-2 | Frequency Standard Internal Adjustment Controls..... | 7-5 |


## LIST OF TABLES


| Table | Title | Page |
|---|---|---|
| 1-1 | Frequency Standard Controls, Indicators, and Connectors..... | 1-3 |
| 5-1 | Common Troubles and Probable Malfunctioning Circuits..... | 5-2 |
| 6-1 | List of Replaceable Parts..... | 6-4 |
| 6-2 | Federal Supply Code for Manufacturers..... | 6-9 |

# SECTION I
# GENERAL DESCRIPTION

1-1. SCOPE OF SECTION.

1-2. This section describes the purpose and physical characteristics of the Sulzer Laboratories, all-silicon, solid state Frequency Standard Model 5B. It provides a brief functional description of the operating controls and indicators.

1-3. PURPOSE OF EQUIPMENT.

1-4. The frequency standard is designed to provide a highly accurate and stable standard for laboratory use, but is also suitable for use in timing and synchronous communications systems.

1-5. DESCRIPTION OF EQUIPMENT.

1-6. The frequency standard (figure 1-1) is 4.5 inches high, 4.5 inches wide, 14.25 inches deep, and weighs approximately 6.5 pounds. The rack mounted model (figure 1-2) is 19 inches wide and 5.25 inches high. It contains a crystal oscillator, an inner and outer oven, and associated frequency control and divider circuitry. Refer to table 1-1 for a functional description of the frequency standard controls, connectors, and indicators.

1-7. ELECTRICAL SPECIFICATIONS.

1-8. The electrical specifications of the frequency standard are listed in the following paragraphs.

1-9. OUTPUT REQUIREMENTS.

| | | |
|---|---|---|
| 1-10. | Frequencies | 100 kHz, 1 MHz, and 5 MHz simultaneously available. 5 MHz and 1 MHz outputs have spectral purity filters. |
| 1-11. | Voltage | 1 volt rms (-20%, +50%) for all three frequencies. Non-harmonically related outputs more than 80 dB down from rated output. |

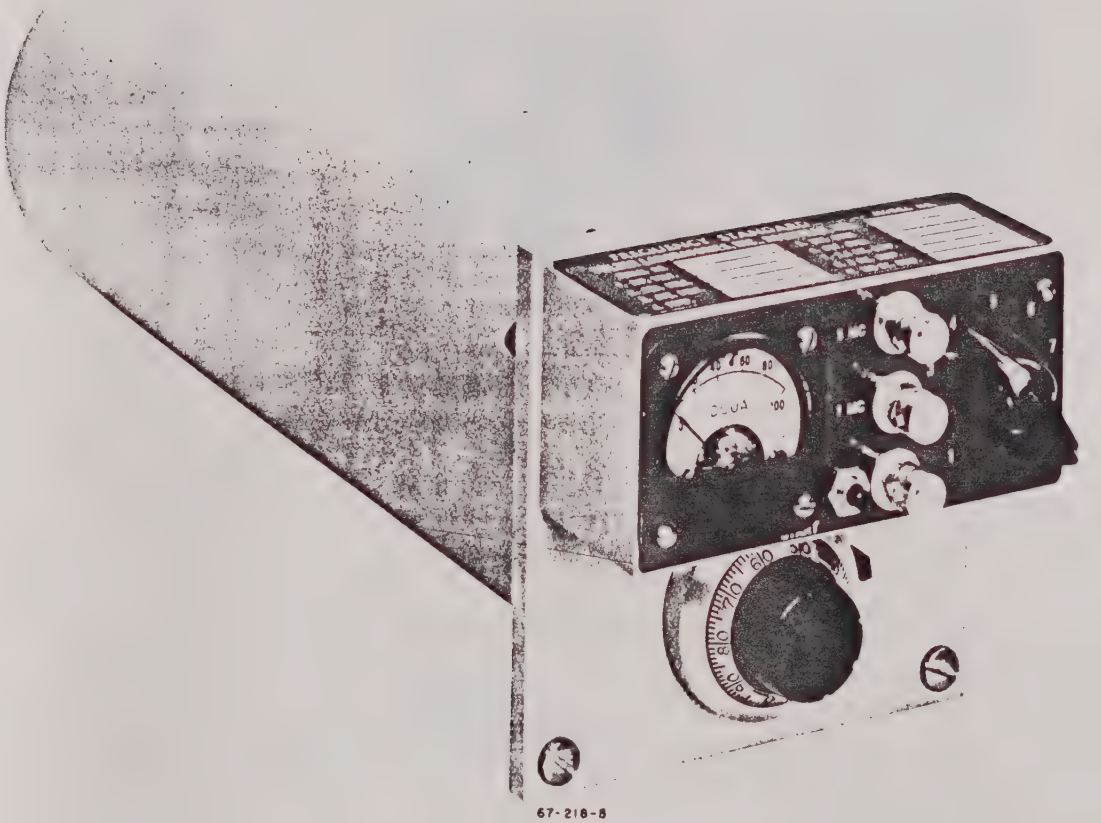


Figure 1-1. Frequency Standard Model 5B.

Figure 1-2. Rack Mounted Frequency Standard with Power Supply.

Table 1-1

Frequency Standard Controls, Indicators, and Connectors

| Name | Reference Designation | Function |
|---|---|---|
| Meter | M1 | Provides readout for circuit monitor point selected by front panel selector. |
| Meter selector | S2 | Selects internal circuit points for monitoring by front panel meter as follows:<br>Position — Monitor Point<br>1 — DC input. (22-32 vdc on 50 volt scale.) |

Table 1-1 (Continued)

| Name | Reference Designation | Function | |
|---|---|---|---|
| Meter selector | S2 | Position | Monitor Point |
| | | 2 | Voltage regulator output. (16-18 vdc on 25 volt scale.) |
| | | 3 | AVC amplifier output voltage. (arbitrary scale.) |
| | | 4 | Inner oven temperature. (Reads 0 when temperature has stabilized.) |
| | | 5 | Inner oven heater voltage. (25 volts dc full scale.) |
| | | 6 | Outer oven heater voltage. (25 volts dc full scale.) |
| | | 7 | 5 MHz output signal. (1 volt rms on arbitrary scale.) |
| | | 8 | 1 MHz output signal. (1 volt rms on arbitrary scale.) |
| | | 9 | 100 kHz output signal. (1 volt rms on arbitrary scale.) |
| 5 MHz | J2 | Provides connection of 5 MHz output to external equipment. | |

Table 1-1 (Continued)

| Name | Reference Designation | Function |
|---|---|---|
| 1 MHz | J3 | Provides connection of 1 MHz output to external equipment. |
| 100 KHz | J4 | Provides connection of 100 kHz output to external equipment. |
| START push-button | S3 | Applies dc output of voltage regulator to oscillator in 5 MHz and 1 MHz dividers to start divider chain. |
| Frequency adjust | C3 | Adjusts crystal oscillator frequency 1 part in $10^7$ over entire range in increments of 1 part in $10^{10}$ for each front panel dial division. |
| Connector | J5 | Provides connection of dc power to frequency standard and connection of frequency standard output signals to external equipment. (On rear of front panel.) |
| Connector | J6 | Provides connection of external dc voltage to optional electrical frequency tuning circuit in frequency standard. (On rear of front panel.) |

1-12. Frequency Stability

Short term stability: 1 second averaging, 8 parts in $10^{11}$; 0.1 second averaging, 8 parts in $10^{10}$.

Maximum $\Delta F/F$ for indicated change is as follows:

| Change | ΔF/F |
|---|---|
| 27 vdc input changed ±5 volts | <2 parts in $10^{10}$ |
| 50 ohm load changed ±20% | <1 part in $10^{10}$ |
| 25 °C ambient temperature changed ±35 °C | <5 parts in $10^{10}$ |

1-13. Aging Rate — For 24 hour period: 5 parts in $10^{10}$ (after 90 days continuous operation)

1-14. POWER REQUIREMENTS — 27 (±5) volts dc, 0.25 amperes, less than 100 millivolts rms ripple (at 25 degrees C). When power is first applied, current will be 0.45 amperes maximum until oven heaters stabilize.

# SECTION II
# INSTALLATION

2-1. SCOPE OF SECTION.

2-2. This section provides instructions for installation of the frequency standard and connection of external power sources.

2-3. INSTALLATION.

2-4. Carefully unpack and examine the frequency standard for possible damage during shipment. Special attention should be given to areas where the outside shipping package was damaged.

**CAUTION**

To prevent over heating crystal oscillator, always provide adequate ventilation in mounting enclosure. Temperature in mounting enclosure should not exceed 35 degrees C.

2-5. RACK MOUNTING. The frequency standard can be factory mounted in a 19 inch rack panel either by itself, with another frequency standard, or with a Power Supply Model 5P. If the frequency standard is not factory mounted, it can be mounted in any suitable rack panel or cabinet. Refer to figure 2-1 for a template of the panel cutout required to mount the frequency standard. The frequency standard fastens to the rack panel with four 10-24 screws in its front panel.

2-6. If the frequency standard will be used as a mobile unit, the optional rear clamp (part number S-38181-2) should be used to support the rear of the frequency standard. The rear clamp must be supported with two side plates fastened between the panel and the rear clamp. The distance the rear clamp is positioned from the panel is not critical and can be changed to meet different mounting requirements. Figure 2-2 provides an outline of the frequency standard showing its center of gravity.

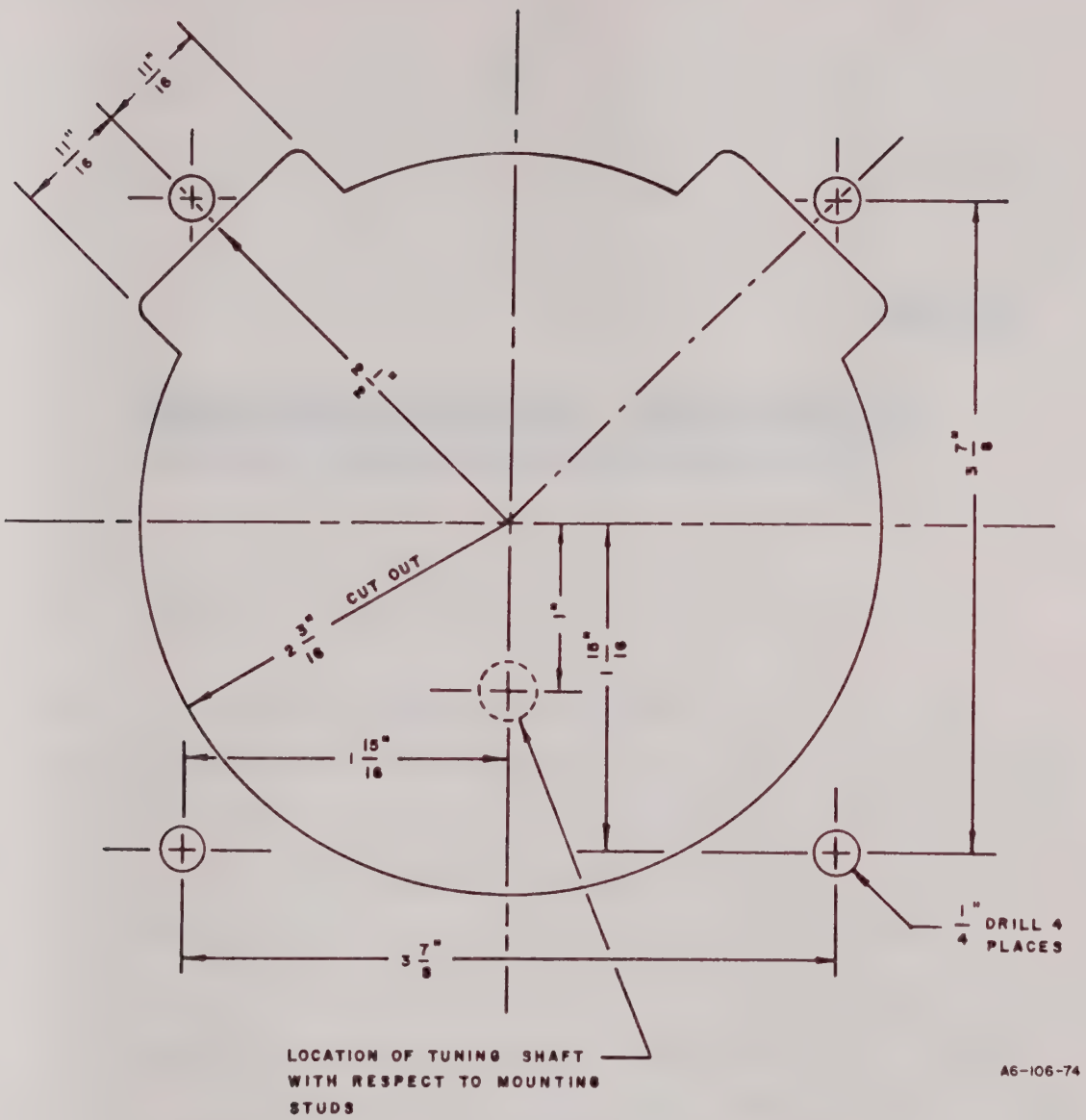


Figure 2-1. Rack Panel Mounting Template.

2-7. Refer to Appendix A Section II if optional power supply Model 5P is being used and was not factory mounted with frequency standard.

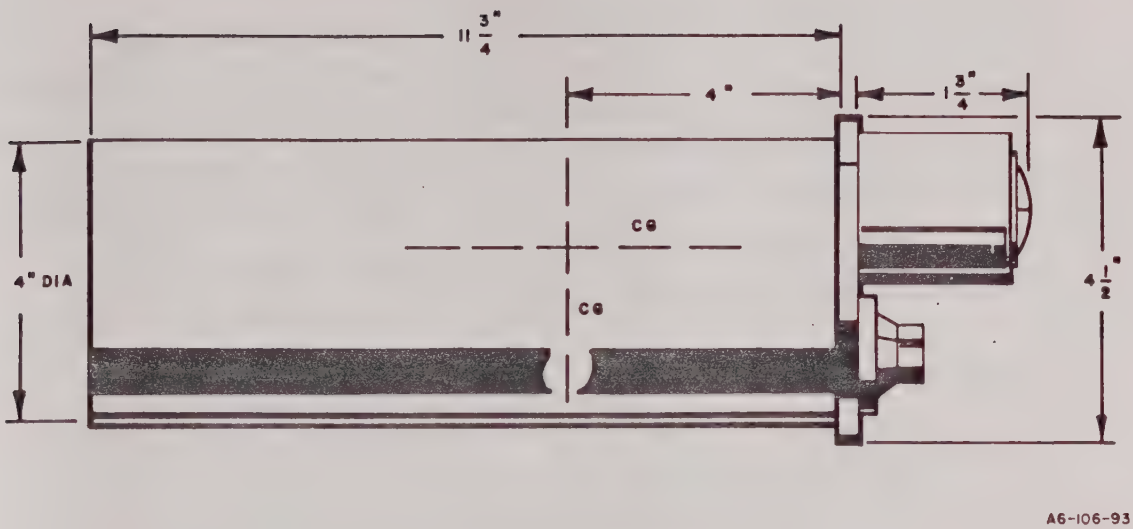


Figure 2-2. Frequency Standard Center of Gravity.

2-8. ELECTRICAL TUNING CONNECTIONS. When the frequency standard is equipped with the optional electrical tuning circuit, it is shipped with a 4 volt mercury battery across pins A and B on connector J6. If the electrical tuning option will not be connecte the battery should remain connected. Without this reference voltag the frequency standard output frequency will be unstable.

2-9. When the external electrical tuning circuitry is ready to be connected, disconnect the 4 volt mercury battery and connect the electrical tuning equipment to the same pins on connector J6.

2-10. POWER CONNECTIONS. The power supply Model 5P, when factory mounted with the frequency standard, should be already connected to the frequency standard. Check that power supply cable is securely connected to connector J5 on rear of frequency standard front panel.

2-11. Any commercial dc power supply meeting the requirements specified in paragraph 1-14, can be used if the power supply Model 5P is not used. The commercial power supply output must be fused with a 1 ampere, fast acting fuse. Connect the commercial power supply to the frequency standard as follows:

a. Connect power supply positive terminal to pin B (red) on connector J5 on rear of frequency standard front panel.
b. Connect power supply negative terminal to pin A (purple) on connector J5.
c. Connect all shields to chassis ground in the frequency standard through pin C (black) on connector J5.

**NOTE**

The frequency standard does not have an internal ground for the power supply; therefore either lead may be grounded. Once a ground is selected it must be used consistently for all interconnections.

# SECTION III
# OPERATION

3-1. SCOPE OF SECTION.

3-2. This section provides detailed procedures for operation of the frequency standard.

3-3. EQUIPMENT TURN ON.

3-4. Turn on frequency standard and power supply as follows:

CAUTION

If optional power supply Model 5P is being used with the frequency standard, do not attempt to operate power supply before reading Operation and Service Manual supplied in Appendix A of this manual.

a. Connect power supply to facility power and set POWER switch on. If facility power is not available, set POWER switch on and press START pushbutton on power supply.

b. Press START pushbutton on frequency standard to start divider chain.

c. Allow frequency standard to warmup for 48 hours.

d. Set meter selector to position 4 to monitor inner oven temperature. The temperature is stabilized when meter indicates zero. Meter indicates low

d. (cont'd) temperature deviation from nominal of approximately 1 degree C per major division. If meter indication is below zero, temperature is high.

**NOTE**

Meter selector should remain in position 4 during normal operation. Do not leave selector in position 3 with meter selector in this position, there is a slight frequency shift in frequency standard output.

3-5. ELECTRICAL TUNING OPERATION.

3-6. If the frequency standard is equipped with optional electrical tuning, its output frequency can be changed using an external, variable dc source. The range of frequency change is 1 part in $10^8$ when the external voltage is changed from 1 to 7 volts. The change sensitivity is approximately 1 part in $10^9$ per volt at 4 volts.

3-7. The frequency standard is now ready for use.

# SECTION IV
# THEORY OF OPERATION

4-1. SCOPE OF SECTION.

4-2. This section provides a general description of the overall operation of the frequency standard and detailed analysis of its individual circuits. This analysis is supported by block diagrams and references to the schematic diagram as required.

4-3. FUNCTIONAL ANALYSIS.

4-4. The frequency standard can be divided into three main operational sections; the dc power regulating section, the frequency control section, and the temperature control section. Refer to figure 4-1 for a functional block diagram and to figure 7-1 for a schematic diagram of the frequency standard.

4-5. DC POWER REGULATING SECTION. The dc power regulating section consists of a passive inductive-capacitive (LC) filter network and a voltage regulator. The filter network filters the dc input voltage from the power supply and the voltage regulator stablizes the filter output voltage, which can vary from 22 to 32 volts, at 16.5 volts. The voltage regulator output is used by all circuits except the outer oven heater and output amplifier.

4-6. FREQUENCY CONTROL SECTION. The frequency control section consists of a 5 MHz crystal and oscillator circuit, an automatic voltage control (AVC) amplifier, a buffer amplifier, three frequency dividers, and an amplifier for each of the three frequency outputs.

4-7. The crystal drives the oscillator at a frequency of 5 MHz, which is the fifth overtone of the fundemental crystal frequency. The oscillator output is amplified and controlled by the AVC amplifier. When the oscillator is first energized, it has a very low output amplitude. As it increases and becomes sufficiently great, the oscillator receives dc feedback from the

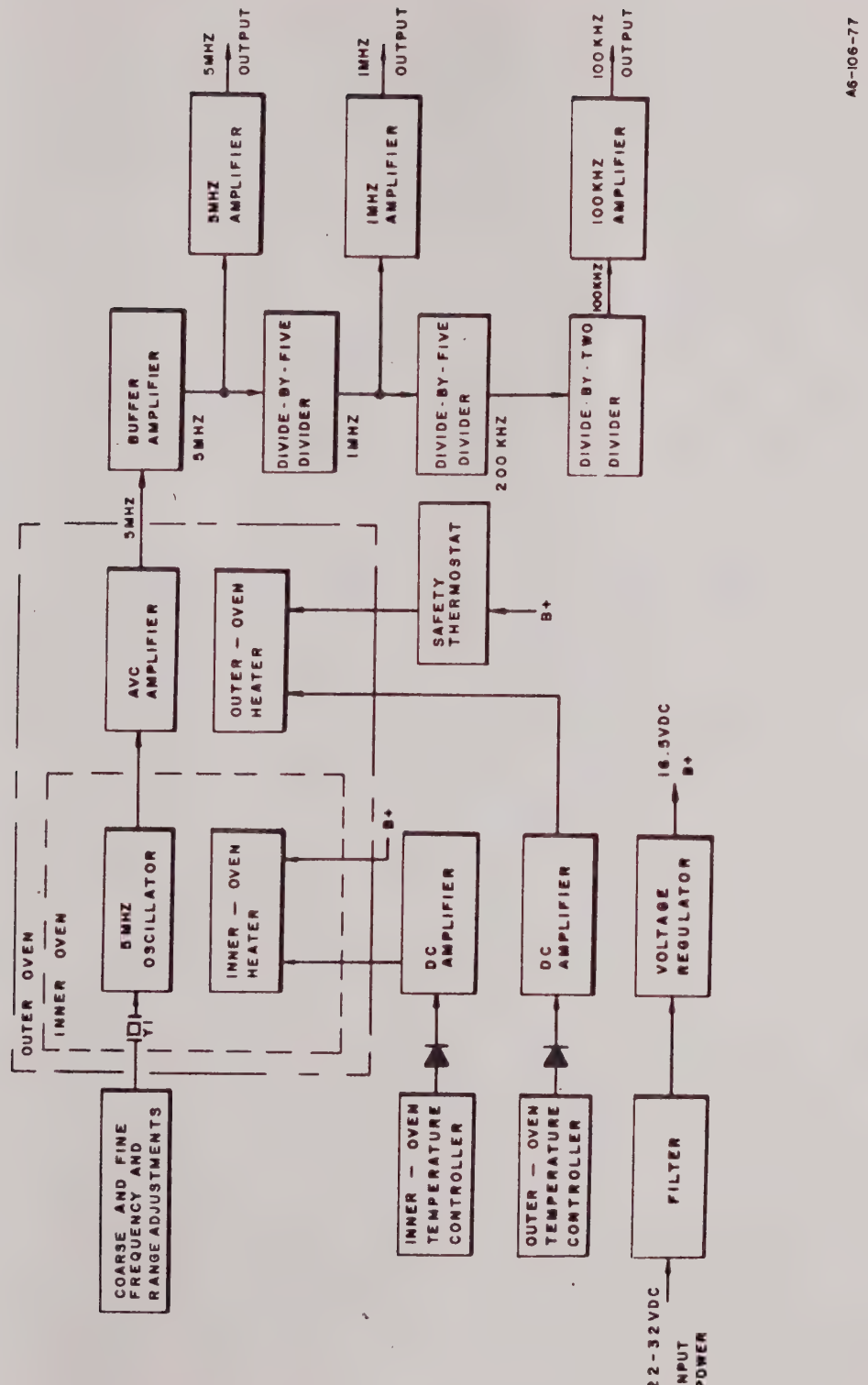


Figure 4-1. Frequency Standard Functional Block Diagram.

the AVC amplifier. This dc feedback decreases the oscillator output amplitude, which in turn reduces the dc feedback. When this output reaches equilibrium, the crystal power is stablized at approximately 1/4 of a microwatt. The AVC amplifier output is buffered by the buffer amplifier. This signal is sent to a divide-by-five frequency divider and to a 5 MHz amplifier for use as the 5 MHz output. The frequency divider has a 1 MHz output. This output is sent to another divide-by-five frequency divider and to a 1 MHz amplifier for use as the 1 MHz output. This frequency divider has a 200 kHz output. Its output is sent to a divide-by-two frequency divider, which has a 100 kHz output. This output is sent to a 100 kHz amplifier for use as the 100 kHz output.

4-8. TEMPERATURE CONTROL SECTION. The temperature control section consists of an inner oven, which contains the crystal and the oscillator; the outer oven, which contains the inner oven, the inner oven temperature controller, and the AVC amplifier; and the two associated temperature control circuits.

4-9. The outer oven temperature controller is a two stage amplifier with an intermediate buffer stage. The last stage oscillates at 25 kHz. The amplifier output is coupled to a resistor-thermistor bridge through a transformer. The bridge output is connected to the amplifier input to provide positive feedback when the oven temperature is low. This causes the last stage of the amplifier to oscillate. This 25 kHz signal is rectified and doubled by a two stage dc amplifier and heats the heater winding wound around the outer oven. As the oven heats the bridge approaches a balance point, reducing the amount of positive feedback to the amplifier. This reduces the oscillation amplitude of the amplifier, reducing the dc heater voltage. This circuit reaches an equilibrium when power supplied to the oven equals the amount of power required to maintain a desired temperature. The stability of the outer oven is better than one degree C.

4-10. The inner oven controller is identical to the outer oven circuit except for component values and power dissapated. The inner oven decreases the temperature variations of the outer oven by a factor of 600 or 1/600 degree C. The inner oven operates at the crystal turning point, or minimum point on the frequency-temperature characteristic curve. This means temperature variations in the crystal cause a minimum amount of frequency change.

4-11. DETAILED THEORY OF OPERATION.

4-12. The frequency standard contains a 5 MHz crystal, an oscillator, an AVC amplifier, a buffer amplifier, two divide-by-five dividers, a divide-by-two divider, a 5 MHz output amplifier, a 1 MHz output amplifier, a 100 kHz output amplifier, two oven temperature controllers, and a dc voltage regulator and filter.

4-13. 5 MHz OSCILLATOR. The 5 MHz oscillator is a modified Pierce type oscillator with the crystal connected between the base of transistor Q1 and ground through a frequency setting network. The frequency setting network consists of coarse frequency adjusting capacitor C2 in series with inductor L1, which is in series with the front panel fine frequency adjusting capacitor C3. Inductor L1, in series with the internal inductance of the crystal, sets the crystal to the desired frequency. The oscillator output is coupled through the tapped winding of toroid transformer T1 to the 5 MHz AVC amplifier. Transformer T1 has an output of 0.008 volts rms, this provides 1.1 volts dc feedback at the base of transister Q1 when the oscillator is stabilized. It also rejects the fundamental and third overtone frequencies of the crystal oscillator. Ferrite bead, L6, damps out high frequency oscillation between 3 and 500 MHz.

4-14. AVC AMPLIFIER. The AVC amplifier maintains low crystal output power for more efficient operation. The oscillator output is amplified by the two stage amplifier consisting of transistors Q2 and Q4. Transistor Q3 is an intermediate buffer stage.

4-15. When the crystal oscillator is first energized, the oscillation amplitude is very low. As the oscillation amplitude increases, diodes CR2 and CR3 begin to rectify. The dc output from the diodes feeds back to the base of transistor Q1, decreasing its base current. This decreases the transconductance of transistor Q1, decreasing its oscillation amplitude, which in turn decreases the dc feedback from the diodes. When it reaches an equilibrium, the oscillation amplitude produces just enough feedback to maintain correct crystal power, which is approximately one quarter microwatt. The 5 MHz output of the AVC amplifier is coupled through transformer T2 to the buffer amplifier circuit.

4-16. BUFFER AMPLIFIER. The buffer amplifier, transistor Q18, is an interstage buffer between the AVC amplifier and the first frequency divider. Transistor Q18 is connected in a common emitter configuration. Its primary function is impedance matching between the AVC amplifier and the first frequency divider. Its output is coupled through transformer T5, which is tuned to 5MHz, to the first frequency divider and to the 5MHz amplifier as a frequency standard output.

4-17. FREQUENCY DIVIDER. The frequency standard contains three series connected frequency dividers. The first in the series divides the 5 MHz signal down to 1 MHz, the second divides the 1 MHz signal down to 200 kHz, and the third divides the 200 kHz signal down to 100 kHz. The first two dividers (divide-by-five dividers) are functionally the same, but operate at different frequencies.

4-18. Divide-By-Five Divider. The divider consists of three parts; a divider starter, a 1 MHz-to-4 MHz multiplier, and a mixer. Refer to figure 4-3 for a functional block diagram of the divide-by-five divider.

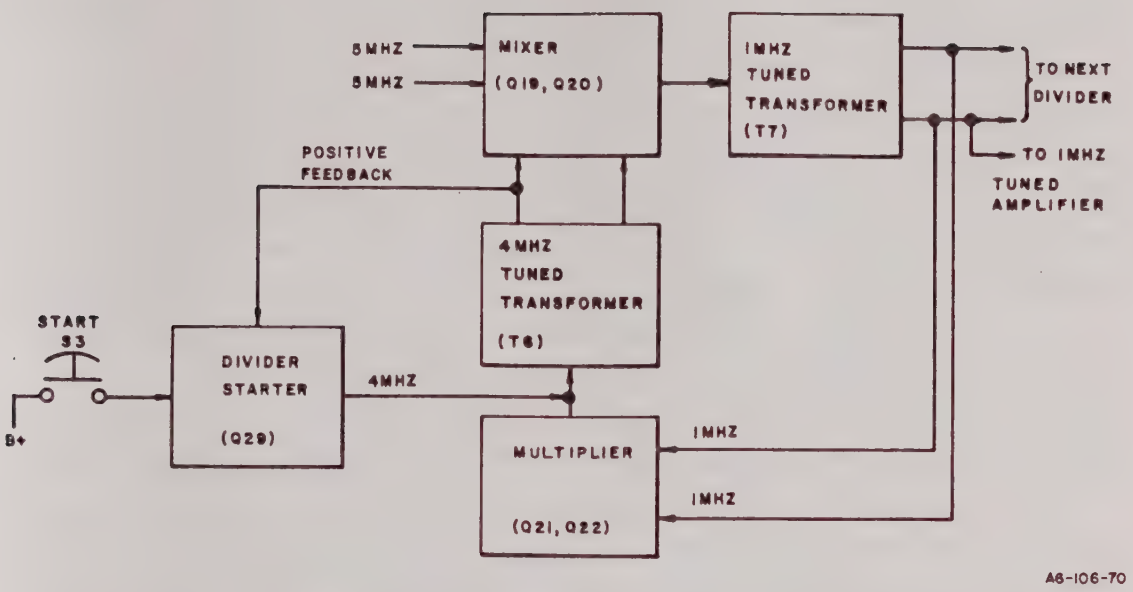


Figure 4-2. Divide-By-Five Divider Functional Block Diagram.

4-19. When the frequency standard is first installed, or after it has been turned off for any reason, the START pushbutton on the front panel must be pressed to start the divider. When this pushbutton is pressed, a dc voltage from the line filter is sent to the divider starter, transistor Q29. Transistor Q29 begins to oscillate at 4 MHz since its output is connected to the 4 MHz tank circuit, consisting of tuned transformer T6 and capacitor C42. Transistor Q29 receives feedback from the secondary of transformer T6 to sustain its oscillation. The center tapped secondary of transformer T6 is connected to the mixer to provide its second input. One half of the secondary is connected to transistor Q19; the other half to transistor Q20. The mixer combines the 5 MHz input signal, from tuned transformer T5, with the 4 MHz signal, and has an output equal to the difference between the two frequencies, or 1 MHz. The 5 MHz signal is applied to the bases of transistors Q19 and 20, the 4 MHz signal to the emitters, and the 1 MHz output is on the collectors. This output signal is coupled through tuned transformer T7 which filters out

unwanted frequencies produced by the mixer. The two output signals from the center tapped secondary of transformer T7 are sent back to the multiplier, which multiplies the signals to a single 4 MHz signal. When the START pushbutton is released, transistor Q29 stops oscillating. The multiplier supplies the 4 MHz signal required by the mixer. The divide-by-five divider now operates as a regenerative divider. The center tapped secondary of transformer T7 is also connected to the next divide-by-five divider and to the 1 MHz tuned amplifier.

4-20. The other divide-by-five divider divides the 1 MHz signal down to 200 kHz using a divider starter and multiplier that operate at 800 kHz. The 200 kHz signal is coupled through tuned transformer T9 to the divide-by-two divider.

4-21. Divide-By-Two Divider. The divide-by-two divider is self starting and converts the 200 kHz signal to a 100 kHz signal. The divider is a mixer consisting of transistors Q27 and Q28. The 100 kHz output of the center tapped secondary of transformer T10 is returned to transistors Q27 and Q28 where it mixes with the 200 kHz signal to provide a stable output equal to the difference between the two frequencies, or 100 kHz. This signal is sent to the 100 kHz tuned amplifier.

4-22. TUNED AMPLIFIER. The frequency standard has three tuned amplifiers; one for each of the three output frequencies of 5 MHz, 1 MHz, and 100 kHz. The three amplifiers are functionally the same. The 5 MHz and 1 MHz amplifiers each have a crystal filter in the input circuit, Y2 and Y3 respectively, to improve the spectral purity of the signals.

4-23. The amplifier is a single stage, common emitter configuration with a tuned output circuit. It produces an output of 1 volt rms into a 50 ohm load.

4-24. DC VOLTAGE REGULATOR AND FILTER. The line filter; consisting of inductors L2, L3, L4, and L5 and capacitors C71, C72, C73, and C74; removes high frequency voltages from the dc

input that would interfere with the operation of the frequency standard. It also helps prevent radio frequency (rf) radiation of the signal frequencies in the frequency standard. Diode CR15, in the positive dc input line to the filter, protects against polarity reversal of the dc input. The filter output is used to start the divider chain and is sent to the voltage regulator.

4-25. The voltage regulator; consisting of transistors Q15, Q16, and Q17; regulates the input voltage, which can vary from 22 to 32 volts, to 16.5 ($\pm$0.1) volts for use by all the frequency control circuits and the inner oven heater. (The outer oven heater and output amplifier uses unregulated 27 volt dc power.)

4-26. The output of the line filter is amplied to the collector of transistor Q15 as the voltage regulator input. The voltage regulator output at the emitter of transistor Q15 is controlled by the dc current from transistor Q16. Transistor Q16 couples the dc voltage from transistor Q17, which compares part of the voltage regulator output to the dc voltage across diode CR8 and has a dc output proportional to the difference between these two voltages. If the voltage regulator output is low, transistor Q17 starts to turn off, increasing the base current of transistor Q16. This increases the base current of transistor Q15. By increasing the base current of transistor Q15, the voltage drop across transistor Q15 decreases, which increases the output of the voltage regulator.

4-27. OVEN TEMPERATURE CONTROLLER. The temperature controllers for the inner and outer ovens provide a highly stabilized thermal environment for the crystal, and its oscillator, located inside the inner oven. The inner and outer oven temperature controllers are functionally the same, therefore only the detailed theory of operation for the inner oven will be presented in the following paragraph. Refer to figure 4-3 for a functional block diagram of the inner oven temperature controller.

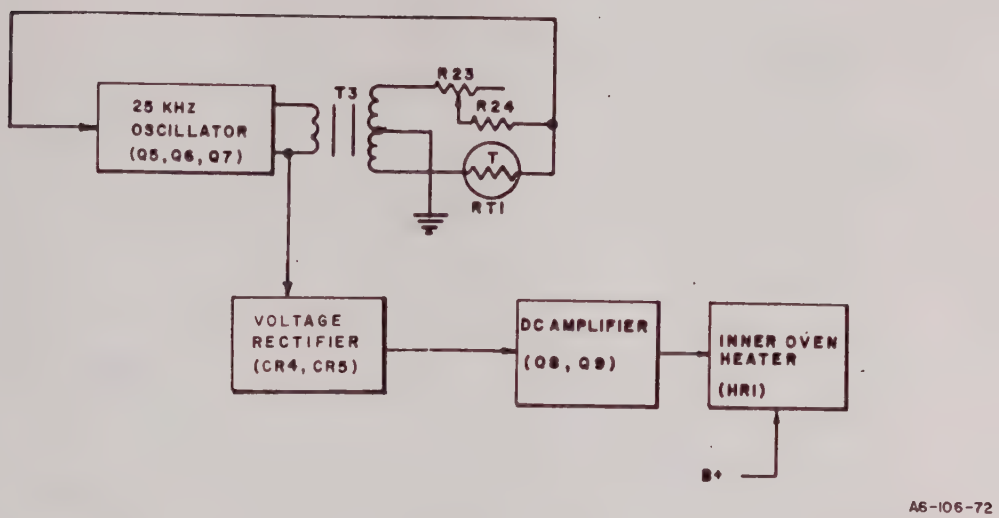


Figure 4-3. Inner Oven Temperature Controller Functional Block Diagram.

4-28. The temperature controller consists of a two stage oscillator, with an intermediate buffer stage, a resistor-thermistor bridge, and a two stage heater voltage amplifier. The three stage oscillator is made up of common emitter transistor Q5 direct coupled to emitter follower transistor Q6, which is direct coupled to common emitter transistor Q7. The output of transistor Q7 is connected to the primary winding of transformer T3. Both halves of the center tapped secondary winding of the transformer are connected to the bridge circuit consisting of potentiometer R23 and resistor R24, as one half of the bridge, and thermistor RT1, as the other half of the bridge. When the oven is below its operating temperature, the resistance of thermistor RT1 is higher than its normal value. This unbalances the bridge circuit, which is connected to transistor Q5 as the oscillator input, causing positive feedback. This cuases the oscillation amplitude to increase.

4-29. The oscillator output is coupled to the two stage dc amplifier, consisting of transistors Q8 and Q9, through diodes CR4 and CR5, which rectify the 25 kHz signal. The output of transistor Q9 is applied to the inner oven heater HR1. As the oven temperature increases, the resistance of thermistor RT1 decreases, causing the bridge circuit to approach a balance. This reduces the positive feedback, reducing the amplitude of the oscillator output, which reduces the heater current. The oven temperature reaches an equilibrium when the power supplied to the heater equals the amount of power required to maintain the desired temperature. Potentiometer R23 adjusts the feedback of the controller circuit which determines the temperature at which the oven operates.

# SECTION V
# MAINTENANCE

5-1. SCOPE OF SECTION.

5-2. This section provides a list of all special test equipment required, a table of common malfunctions and probable causes, and calibration procedures for adjusting the output frequency and for aligning the tuned transformers in the frequency standard.

5-3. TEST EQUIPMENT REQUIRED.

5-4. All special test equipment required to analyze malfunctions and perform required calibrations is as follows:

a. Primary frequency standard or VLF receiver (TRACOR Series 599).
b. Frequency difference meter (TRACOR Model 527A) or phase comparator (TRACOR Model 1LPD).
c. 4 volt rms, 5 MHz to 200 kHz source.
d. Oscilloscope or vacuum tube voltmeter with high impedance probe (15 pf or less).
e. 0-30 volt, 0.5 ampere dc power supply.

5-5. TROUBLE ANALYSIS.

5-6. The operator should become familiar with the operating instructions in section III and the theory of operation in section IV before performing a trouble analysis on the frequency standard. Table 5-1 lists the most common troubles and associated probable malfunctioning circuits.

5-7. CALIBRATION.

5-8. This paragraph provides procedures for adjustment of the frequency output and alignment of the tuned transformers of the frequency standard. Refer to the schematic diagram (figure 7-1) to aid in locating the components requiring adjustment. Figure 7-2 shows the location of the tuned transformers and frequency adjustment controls in the frequency standard.

Table 5-1
Common Troubles and Probable Malfunctioning Circuits

| Trouble | Probable Malfunctioning Circuit |
|---|---|
| No frequency outputs present | Power supply fuse<br>Voltage regulator<br>AVC amplifier<br>Buffer amplifier |
| 100 kHz output not present, but 5 MHz and 1 MHz outputs present | 100 kHz amplifier<br>Divide-by-two divider<br>Second divide-by-five divider (1 MHz to 200 kHz) |
| 100 kHz and 1 MHz outputs not present, but 5 MHz output present | Press START pushbutton<br>First divide-by-five divider (5 MHz to 1 MHz) |
| 1 MHz output not present, but 5 MHz and 100 kHz outputs present | 1 MHz amplifier |
| 5 MHz output not present, but 1 MHz and 100 kHz outputs present | 5 MHz amplifier |
| All output frequencies off by small amount, but output voltages normal | Inner oven<br>Frequency requires adjustment after long period of operation or storage |
| All output frequencies off by large amount, but output voltages normal | Outer oven |

5-9. FREQUENCY ADJUSTMENT. Because of the aging rate of the crystal, the frequency change will require compensation using either the front panel fine adjustment or the internal coarse adjustment. Whenever a frequency adjustment is made, the frequency standard output must be compared to an external frequency reference. This can be done using either of the following methods:

a. The two signals can be compared using a phase comparator such as the TRACOR Model 1LPD.

b. The two signals can be compared using a frequency difference meter such as the TRACOR Model 527A.

5-10. Either one of the following references can be used as the external frequency reference:

a. Another frequency standard can be used as the external reference.

b. The signals broadcast by the National Bureau of Standards (NBS) stations WWVB (20kHz) or WWVL (60 kHz) can be used as the external reference.

5-11. Another method that can be used, is comparing the NBS high frequency station WWV ground wave to the frequency standard output on a chart recorder as a beat frequency difference. However, this method requires at least 48 hours to check the frequency standard to an accuracy of 1 part in $10^{10}$. These two signals can also be compared on the chart recorder using the "time ticks". This method requires several weeks to check the frequency standard to an accuracy of 1 part in $10^{10}$, during which time crystal aging can be sufficient to prevent achieving this accuracy.

5-12. Fine Frequency Adjustment. Adjust the frequency standard output using the front panel control as follows:

a. Insure frequency standard has been operating for minimum of 48 hours before proceeding.

b. Set meter selector to position 4 to check that inner oven temperature has stabilized. Meter should indicate zero.

c. Connect frequency standard 5 MC connector, or pin D on dc power input connector, to frequency difference measuring instrument.

d. Connect primary frequency reference to frequency difference measuring instrument.

**NOTE**

Frequency standard output will change approximately 1 part in $10^{10}$ for each minor division front panel control is adjusted.

e. Determine amount of adjustment required using frequency difference measuring instrument.

f. Adjust front panel control for required frequency change. Clockwise adjustment increases frequency and counterclockwise adjustment decreases frequency.

g. Allow frequency standard to stabilize for several seconds, then determine if further adjustment is required using frequency difference measuring instrument.

h. Readjust front panel control as required. If front panel control reaches end of range before required frequency change can be made, an internal coarse frequency adjustment must be made.

5-13. Coarse Frequency Adjustment. Adjust the frequency standard output using the internal control as follows:

a. Remove frequency standard from mountings.

b. Remove outer cylindrical cover from frequency standard.

c. Set meter selector to position 4 to check that inner oven temperature has stabilized. Meter should indicate zero.

d. Set front panel fine adjustment control to 600.

e. Adjust coarse frequency control, inside hole marked FREQUENCY on back of outer oven. Clockwise adjustment decreases frequency and counterclockwise adjustment increases frequency.

f. Allow frequency standard to stabilize for several seconds, then determine if further adjustment is required using frequency difference measuring instrument.

k. Readjust coarse adjustment control as required. If coarse adjustment control reaches end of range before required frequency change can be made, capacitor must be added in parallel with capacitor C1; otherwise, reassemble frequency standard.

5-14. Adding Capacitor. A capacitor will normally have to be added to the circuit after 10 to 15 years of operation. It is recommended that the frequency standard be returned to the factory for this change. The capacitor can be added without returning the frequency standard to the factory. Add the capacitor as follows:

a. Remove dc power from frequency standard.

b. Remove outer oven.

c. Remove inner oven end cover cap.

d. Add 20 to 30 picofarad Corning glass capacitor across capacitor C1. If Corning glass capacitor is not available, a high quality silvered mica capacitor may be used.

e. Replace inner oven end cover cap and outer oven.

f. Apply power to frequency standard and allow to stabilize for 48 hours.

g. Readjust frequency standard frequency in accordance with paragraph 5-13.

5-15. TUNED TRANSFORMER ALIGNMENT. The tuned transformers in the frequency standard will require retuning if the dividers or amplifiers are not functioning properly. This would normally be caused by component values shifting.

5-16. Retune the transformers as follows:

a. Remove all power from frequency standard.

b. Remove frequency standard from mountings.

c. Remove outer cylindrical cover from frequency standard.

**NOTE**

Apply all input signals through 15K source impedance. Make all voltage measurements between the 15K source impedance and the frequency standard. Tolerance on all frequency settings and measurements is ±0.001%.

d. Apply 1 volt rms, 5 MHz signal to transformer T5 primary winding.

e. Adjust tansformer T5 for maximum output at secondary winding.

f. Remove 5 MHz signal and apply 1 volt rms, 1 MHz signal to transformer T7 primary winding.

g. Adjust transformer T7 for maximum output at secondary winding.

h. Remove 1 MHz signal and apply 1 volt rms, 4 MHz signal to transformer T6 primary winding.

i. Adjust transformer T6 for maximum output at secondary winding.

j. Remove 4 MHz signal and apply 1 volt rms, 200 kHz signal to transformer T9 primary winding.

k. Adjust transformer T9 for maximum output at secondary winding.

l. Remove 200 kHz signal and apply 1 volt rms, 800 kHz signal to transformer T8 primary winding.

m. Adjust transformer T8 for maximum output at secondary winding.

n. Remove 800 kHz signal.
o. Connect dc power supply to connector J5 pin B(+) and pin A(-).
p. Set dc power supply to 26.5 volts.
q. Press START pushbutton.
r. Measure voltage at transistor Q18 collector. Voltage shall be 22 volts peak to peak (±5%).
s. Check that all three frequency outputs are present. If outputs are present, proceed to step u.
t. Press and hold START pushbutton while adjusting two tuned transformers on divider not operating. Adjust transformers until divider operation is stable at correct frequency when START pushbutton is released.
u. Adjust transformer T10 for maximum output at secondary winding.
v. Adjust transformers T11, T12, and T13 for 1 volt rms, 5 MHz output into 50 ohms at 5 MC connector.
w. Adjust transformers T14, T15, and T16 for 1 volt rms, 1 MHz output into 50 ohms at 1 MC connector.
x. Adjust transformers T17, T18, and T19 for 1 volt rms, 100 kHz output into 50 ohms at 100 KC connector.
y. Reassemble frequency standard.

5-17. Frequency standard is now ready for use.

# SECTION VI
# REPLACEABLE PARTS

6-1. SCOPE OF SECTION.

6-2. This section provides all necessary information for quick identification of replaceable parts for the frequency standard. The section contains a list of replaceable parts and a numeric list of federal supply codes for manufacturers.

6-3. LIST OF REPLACEABLE PARTS.

6-4. A list of replaceable parts for the frequency standard is presented in table 6-1. Information in the table includes the reference designation, part description, Sulzer Laboratories stock number, federal supply code for manufacturers (FSCM), and manufacturer part number, presented in that order.

6-5. REFERENCE DESIGNATION. The reference designation is an alpha-numeric identification assigned to each assembly and to electrical components within an assembly. Reference designations are obtained by referring to the schematic diagram (figure 7-1) or by markings on the assembly.

6-6. PART DESCRIPTION. All parts are described using the noun-modifier method. For example, a 2500 ohm variable resistor is described as: RES VAR 2X2 K. The "X" between the "2" and the "5" represents the decimal location.

6-7. SULZER LABORATORIES STOCK NUMBER. A Sulzer Laboratories stock number is assigned to replaceable parts in the frequency standard. Identical parts have identical stock numbers. Presently, only replaceable parts manufactured or assembled by Sulzer Laboratories have a stock number assigned to them.

6-8. FEDERAL SUPPLY CODE FOR MANUFACTURERS.

6-9. A list of manufacturers supplying parts for the frequency standard is provided in table 6-2. Information in the table includes the manufacturer federal supply code number, manufacturer's name, and manufacturer's address, presented in

that order. The manufacturers are listed in numerical order by federal supply code number.

6-10. To locate the manufacturer of a part, proceed as follows:

a. Obtain the manufacturer federal supply code number by referring to the List of Replaceable Parts (table 6-1).

b. Locate the federal supply code number in the appropriate column of the Federal Supply Code for Manufacturers (table 6-2).

6-11. ORDERING INFORMATION.

6-12. Address orders or inquiries to either an authorized Sulzer Laboratories Sales Representative or to:

Customer Service
Sulzer Laboratories Division,
TRACOR, Inc.
9610 Bellanca Avenue
Los Angeles, California 90045

6-13. To insure prompt service, orders must include the following information:

a. Name, model, and serial number of the instrument.

b. Reference designation, if applicable.

c. Sulzer Laboratories stock number, if one is assigned.

d. Full description of the part.

6-14. Item a. is located on the instrument; items b., c., and d. are found in the List of Replaceable Parts (table 6-1).

6-15. The part numbers shown will change occasionally as manufacturers' items are reevaluated or as improved components become available. The component shipped will be the component used in production at the time the order is received, and will be equivalent to the component it replaces in both dimensions and performance.

6-16. The minimum billing on any order is $15.00, with a standard delivery of 30 days. All prices are FOB Los Angeles, California, and are subject to change without notice.

# Table 6-1

## List of Replaceable Parts

| REF DES | DESCRIPTION | SULZER LABS STOCK NO. | FSCM | MFR PART NO. |
|---|---|---|---|---|
| C 1 | CAP FXD GLASS SLCD | | 76299 | CYFM10C |
| C 2 | CAP VAR GLASS 28 PFD | | 73899 | MC 603 |
| C 3 | CAP VAR GLASS 18 PFD | S-28010A | 23732 | S-28010A |
| C 4 | CAP FXD GLASS SLCD | | 76299 | CYFM10C |
| C 5 | CAP VAR GLASS 28 PFD | | 73899 | MC603 |
| C 6 | CAP FXD GLASS 680 PFD | | 76299 | CYFM10C681K |
| C 7 | CAP FXD GLASS 220 PFD | | 76299 | CYFM15C221K |
| C 8 | CAP FXD CER X02 MFD | | 00656 | MC80V203AM |
| C 9 | CAP FXD CER X005 MFD | | 00656 | MC80V502AM |
| C 10 | CAP FXD CER X005 MFD | | 00656 | MC80V502AM |
| C 11 | CAP FXD MICA X001 MFD | | 84171 | DM-15E-102-J |
| C 12 | CAP FXD CER X005 MFD | | 00656 | MC80V502AM |
| C 13 | CAP FXD CER X005 MFD | | 00656 | MC80V502AM |
| C 14 | CAP FXD CER X005 MFD | | 00656 | MC80V502AM |
| C 15 | CAP FXD CER X005 MFD | | 00656 | MC80V502AM |
| C 16 | CAP FXD MICA X001 MFD | | 84171 | DM-15E-102-J |
| C 17 | CAP FXD MICA 220 MFD | | 84171 | DM-15E-221-J |
| C 18 | CAP FXD CER X005 MFD | | 00656 | MC80V502AM |
| C 19 | CAP SOLID TA 4X7 MFD | | 56289 | 150D475X0035B2 |
| C 20 | CAP FXD CER X005 MFD | | 00656 | MC80V502AM |
| C 21 | CAP SOLID TA 1X0 MFD | | 56289 | 150D105X0035A2 |
| C 22 | CAP FXD CER X02 MFD | | 00656 | MC80V203AM |
| C 23 | CAP SOLID TA 1X0 MFD | | 56289 | 150D105X0035A2 |
| C 24 | CAP FXD CER X02 MFD | | 00656 | MC80V203AM |
| C 25 | CAP SOLID TA 3X3 MFD | | 56289 | 150D335X0010A2 |
| C 26 | CAP FXD CER X02 MFD | | 00656 | MC80V203AM |
| C 27 | CAP SOLID TA 3X3 MFD | | 56289 | 150D335X0010A2 |
| C 28 | CAP SOLID TA 4X7 MFD | | 56289 | 150D475X0035B2 |
| C 29 | CAP SOLID TA 1X0 MFD | | 56289 | 150D105X0035A2 |
| C 30 | CAP SOLID TA 1X0 MFD | | 56289 | 150D105X0035A2 |
| C 31 | CAP FXD CER X02 MFD | | 00656 | MC80V203AM |
| C 32 | CAP FXD CER X02 MFD | | 00656 | MC80V203AM |
| C 33 | CAP SOLID TA 3X3 MFD | | 56289 | 150D335X0010A2 |
| C 34 | CAP SOLID TA 3X3 MFD | | 56289 | 150D335X0010A2 |
| C 35 | CAP SOLID TA 4X7 MFD | | 56289 | 150D475X0035B2 |
| C 36 | CAP SOLID TA 1X0 MFD | | 56289 | 150D105X0035A2 |
| C 37 | CAP SOLID TA 1X0 MFD | | 56289 | 150D105X0035A2 |
| C 38 | CAP SOLID TA 1X0 MFD | | 56289 | 150D105X0035A2 |
| C 39 | CAP FXD CER X01 MFD | | 00656 | MC80V103AM |
| C 40 | CAP FXD CER 180 PFD | | 00656 | DM-10E-181-J |
| C 41 | CAP FXD CER X01 MFD | | 00656 | MC80V103AM |
| C 42 | CAP FXD MICA 220 PFD | | 84171 | DM-10E-221J |
| C 43 | CAP FXD MICA 330 PFD | | 84171 | DM-15E-331-J |
| C 44 | CAP FXD CER 220 PFD | | 00656 | MC80V221AM |
| C 45 | CAP FXD CER 220 PFD | | 00656 | MC80V221AM |
| C 46 | CAP FXD MICA 330 PFD | | 84171 | DM-15E-331-J |
| C 47 | CAP FXD MICA X0015 MFD | | 84171 | DM-15E-152-J |
| C 48 | CAP FXD CER X001 MFD | | 00656 | MC80V102AM |
| C 49 | CAP FXD CER X001 MFD | | 00656 | MC80V102AM |
| C 50 | CAP FXD MICA 5600 PFD | | 84171 | DM-20E562J |
| C 51 | CAP FXD CER 220 PFD | | 00656 | MC80V221AM |
| C 52 | CAP FXD CER X001 MFD | | 00656 | MC80V102AM |
| C 53 | CAP SOLID TA 4X7 MFD | | 56289 | 150D475X0035B2 |
| C 54 | CAP FXD CER X02 MFD | | 00656 | MC80V203AM |
| C 55 | CAP FXD CER X01 MFD | | 00656 | MC80V103AM |
| C 56 | CAP FXD MICA 100 PFD | | 84171 | DM-15E-101-J |
| C 57 | CAP FXD CER X01 MFD | | 00656 | MC-80V103AM |
| C 58 | CAP FXD CER X02 MFD | | 00656 | MC-80V203AM |
| C 59 | CAP FXD MICA 220 PFD | | 84171 | DM-15E-221-J |
| C 60 | CAP FXD MICA 220 PFD | | 84171 | DM-15E-221-J |
| C 60A | CAP FXD CER X01 MFD | | 00656 | MC-80V103AM |
| C 61 | CAP FXD MICA 1000 PFD | | 84171 | DM-15E-102-J |
| C 62 | CAP FXD CER X02 MFD | | 00656 | MC80V203AM |
| C 63 | CAP FXD CER X02 MFD | | 00656 | MC80V203AM |
| C 64 | CAP FXD MICA 1000 PFD | | 84171 | DM-15E-102-J |
| C 65 | CAP FXD MICA 1000 PFD | | 84171 | DM-15E-102-J |
| C 66 | CAP FXD MICA X0082 MFD | | 84171 | DM-19E-822-J |
| C 66A | CAP FXD MICA SLCD | | 84171 | DM-15-102-J |
| C 67 | CAP SOLID TA 1X0 MFD | | 56289 | 150D105X0035A2 |
| C 68 | CAP FXD CER X02 MFD | | 00656 | MC80V203AM |
| C 69 | CAP FXD MICA X0082 MFD | | 84171 | DM-19E-822-J |

86-7-86 (SEPT'87)

## Table 6-1 (Continued)

| REF DES | DESCRIPTION | SULZER LABS STOCK NO. | FSCM | MFR PART NO. |
|---|---|---|---|---|
| C 70 | CAP FXD MICA X0082 MFD | | 84171 | DM-19E-882-J |
| C 71 | CAP SOLID TA 4X7 MFD | | 56289 | 150D475X0035B2 |
| C 72 | CAP SOLID TA 4X7 MFD | | 56289 | 150D475X0035B2 |
| C 73 | CAP SOLID TA 4X7 MFD | | 56289 | 150D475X0035B2 |
| C 74 | CAP SOLID TA 4X7 MFD | | 56289 | 150D475X0035B2 |
| C 75 | CAP FXD CER X001 MFD | | 00656 | MC80V102AM |
| C 76 | CAP FXD CER X001 MFD | | 00656 | MC80V102AM |
| C 77 | CAP FXD CER X005 MFD | | 00656 | MC80V502AM |
| C 78 | CAP FXD CER X005 MFD | | 00656 | MC80V502AM |
| C 79 | CAP FXD CER X005 MFD | | 00656 | MC80V502AM |
| C 80 | CAP FXD CER 1800 PFD | | 71590 | FT1800 |
| C 81 | CAP FXD CER 1800 PFD | | 71590 | FT1800 |
| E 1 | KNOB | | 83330 | 2223 |
| E 2 | DIAL | | 73138 | RB |
| J 1 | CONNECTOR JACK | | 81312 | SRE7SJ |
| J 2 | CONNECTOR BNC | | 71468 | UG1094U |
| J 3 | CONNECTOR BNC | | 71468 | UG1094U |
| J 4 | CONNECTOR BNC | | 71468 | UG1094U |
| J 5 | CONNECTOR JACK | | 81312 | MRE7PJ |
| J 6 | CONNECTOR JACK | | 81312 | MRE7PJ |
| L 1 | INDUCTOR SLCD | 2.5-L1 | 23732 | 2.5-L1 |
| L 2 | *INDUCTOR | S-18060 | 23732 | S-18060 |
| L 3 | *INDUCTOR | S-18060 | 23732 | S-18060 |
| L 4 | +INDUCTOR | S-18060 | 23732 | S-18060 |
| L 5 | +INDUCTOR | S-18060 | 23732 | S-18060 |
| L 6 | FERRITE BEAD | | 02214 | 56-590-65-3B |
| M 1 | METER | | 38315 | 0-100-DC-UA |
| P 1 | CONNECTOR PLUG | | 81312 | SRE7PJ |
| P 2 | CONNECTOR PLUG | | 81312 | MRE7SJTCH |
| P 3 | CONNECTOR PLUG | | 81312 | MRE7SJTC6H |
| Q 1 | TSTR NPN 40235 | | 02735 | 40235 |
| Q 2 | TSTR NPN 2N2221 | | 01295 | 2N2221 |
| Q 3 | TSTR NPN 2N2221 | | 01295 | 2N2221 |
| Q 4 | TSTR NPN 2N2221 | | 01295 | 2N2221 |
| Q 5 | TSTR NPN 2N697 | | 01295 | 2N697 |
| Q 6 | TSTR NPN 2N697 | | 01295 | 2N697 |
| Q 7 | TSTR NPN 2N697 | | 01295 | 2N697 |
| Q 8 | TSTR NPN 2N697 | | 01295 | 2N697 |
| Q 9 | TSTR NPN 2N697 | | 01295 | 2N697 |
| Q 10 | TSTR NPN 2N697 | | 01295 | 2N697 |
| Q 11 | TSTR NPN 2N697 | | 01295 | 2N697 |
| Q 12 | TSTR NPN 2N697 | | 01295 | 2N697 |
| Q 13 | TSTR NPN 2N697 | | 01295 | 2N697 |
| Q 14 | TSTR NPN 2N1701 | | 02735 | 2N1701 |
| Q 15 | TSTR NPN 2N1701 | | 02735 | 2N1701 |
| Q 16 | TSTR NPN 2N697 | | 01295 | 2N697 |
| Q 17 | TSTR NPN 2N697 | | 01295 | 2N697 |
| Q 18 | TSTR NPN 2N2221 | | 01295 | 2N2221 |
| Q 19 | TSTR NPN 2N2221 | | 01295 | 2N2221 |
| Q 20 | TSTR NPN 2N2221 | | 01295 | 2N2221 |
| Q 21 | TSTR NPN 2N2221 | | 01295 | 2N2221 |
| Q 22 | TSTR NPN 2N2221 | | 01295 | 2N2221 |
| Q 23 | TSTR NPN 2N2221 | | 01295 | 2N2221 |
| Q 24 | TSTR NPN 2N2221 | | 01295 | 2N2221 |
| Q 25 | TSTR NPN 2N2221 | | 01295 | 2N2221 |
| Q 26 | TSTR NPN 2N2221 | | 01295 | 2N2221 |
| Q 27 | TSTR NPN 2N2221 | | 01295 | 2N2221 |
| Q 28 | TSTR NPN 2N2221 | | 01295 | 2N2221 |
| Q 29 | TSTR NPN 2N2221 | | 01295 | 2N2221 |
| Q 29A | TSTR NPN 2N2221 | | 01295 | 2N2221 |
| Q 30 | TSTR NPN 2N2221 | | 01121 | 2N2221 |
| Q 31 | TSTR NPN 2N2221 | | 01121 | 2N2221 |
| Q 32 | TSTR NPN 2N2221 | | 01121 | 2N2221 |
| R 1 | RES FXD COMP 1X0 K | | 01121 | RC07 |
| R 2 | RES FXD COMP 4X7 K | | 01121 | RC07 |
| R 3 | RES FXD COMP 1X0 K | | 01121 | RC07 |
| R 4 | RES FXD COMP 1X0 K | | 01121 | RC07 |
| R 5 | RES FXD COMP 4X7 K | | 01121 | RC07 |
| R 6 | RES FXD COMP 1X0 K | | 01121 | RC07 |
| R 7 | RES FXD COMP 1X5 K | | 01121 | RC07 |
| R 8 | RES FXD COMP 2X2 K | | 01121 | RC07 |

*L2, L3 WOUND ON ONE CORE
+L4, L5 WOUND ON ONE CORE

84-7-86 (SEPT87)

## Table 6-1 (Continued)

| REF DES | DESCRIPTION | SULZER LABS STOCK NO. | FSCM | MFR PART NO. |
|---|---|---|---|---|
| R 9 | RES FXD COMP 10 K | | 01121 | RC07 |
| R 10 | RES FXD COMP 47 OHM | | 01121 | RC07 |
| R 11 | RES FXD COMP 4X7 K | | 01121 | RC07 |
| R 12 | RES FXD COMP 1X0 K | | 01121 | RC07 |
| R 13 | RES FXD COMP 1X0 K | | 01121 | RC07 |
| R 14 | RES FXD COMP 470 OHM | | 01121 | RC07 |
| R 15 | RES FXD COMP 10 K | | 01121 | RC07 |
| R 16 | RES FXD COMP 47 OHM | | 01121 | RC07 |
| R 17 | RES FXD COMP 10 K | | 01121 | RC07 |
| R 18 | RES FXD COMP 6X8 K | | 01121 | RC07 |
| R 19 | RES FXD COMP 10 K | | 01121 | RC07 |
| R 20 | RES FXD COMP 470 OHM | | 01121 | RC07 |
| R 20A | RES FXD COMP 100 OHM | | 01121 | RC07 |
| R 21 | RES FXD COMP 1X0 K | | 01121 | RC07 |
| R 22 | RES FXD COMP 15 K | | 01121 | RC07 |
| R 23 | RES VAR 500 OHM | | 01121 | RC07 |
| R 24 | RES FXD DEP CARB SLCD | | 80294 | 224L-1-501 |
| R 25 | RES FXD COMP 100 K | | 01295 | CR 1/8 |
| R 26 | RES FXD COMP 1X0 K | | 01121 | RC07 |
| R 26A | RES FXD COMP SLCD | | 01121 | RC07 |
| R 27 | RES FXD COMP 47 OHM | | 01121 | RC07 |
| R 28 | RES FXD COMP 10 K | | 01121 | RC07 |
| R 29 | RES FXD COMP 6X8 K | | 01121 | RC07 |
| R 30 | RES FXD COMP 10 K | | 01121 | RC07 |
| R 31 | RES FXD COMP 470 OHM | | 01121 | RC07 |
| R 31A | RES FXD COMP 100 OHM | | 01121 | RC07 |
| R 32 | RES FXD COMP 1X0 K | | 01121 | RC07 |
| R 33 | RES FXD COMP 22 K | | 01121 | RC07 |
| R 34 | RES VAR 2X0 K | | 01121 | RC07 |
| R 34A | RES FXD DEP CARB SLCD | | 80294 | 224L-1-202 |
| R 35 | RES FXD COMP 100 K | | 01295 | CR 1/8 |
| R 36 | RES FXD COMP 1X0 K | | 01121 | RC07 |
| R 37 | RES FXD COMP 47 OHM | | 01121 | RC07 |
| R 38 | RES FXD COMP 3X3 K | | 01121 | RC07 |
| R 39 | RES FXD COMP 4X7 K | | 01121 | RC07 |
| R 40 | RES FXD COMP 470 OHM | | 01121 | RC07 |
| R 41 | RES FXD COMP 2X2 K | | 01121 | RC07 |
| R 42 | RES FXD COMP 10 K | | 01121 | RC07 |
| R 43 | RES FXD COMP 22X1 K | | 01121 | RC07 |
| R 44 | RES FXD COMP 22X1 K | | 01295 | CR 1/8 |
| R 45 | RES VAR 2X0 K | | 01295 | CR 1/8 |
| R 45A | RES FXD DEP CARB SLCD | | 80294 | 224L-1-202 |
| R 46 | RES FXD COMP 4X7 K | | 01121 | RC07 |
| R 47 | RES FXD COMP 22 K | | 01121 | RC07 |
| R 47A | RES FXD COMP 10 K | | 01121 | RC07 |
| R 48 | RES FXD COMP 220 OHM | | 01121 | RC07 |
| R 49 | RES FXD COMP 220 OHM | | 01121 | RC07 |
| R 50 | RES FXD COMP 470 OHM | | 01121 | RC07 |
| R 51 | RES FXD COMP 470 OHM | | 01121 | RC07 |
| R 52 | RES FXD COMP 100 OHM | | 01121 | RC07 |
| R 53 | RES FXD COMP 470 OHM | | 01121 | RC07 |
| R 54 | RES FXD COMP 470 OHM | | 01121 | RC07 |
| R 55 | RES FXD COMP 10 K | | 01121 | RC07 |
| R 56 | RES FXD COMP 10 K | | 01121 | RC07 |
| R 57 | RES FXD COMP 1X0 K | | 01121 | RC07 |
| R 58 | RES FXD COMP 1X0 K | | 01121 | RC07 |
| R 59 | RES FXD COMP 220 OHM | | 01121 | RC07 |
| R 60 | RES FXD COMP 470 OHM | | 01121 | RC07 |
| R 61 | RES FXD COMP 470 OHM | | 01121 | RC07 |
| R 62 | RES FXD COMP 10 K | | 01121 | RC07 |
| R 63 | RES FXD COMP 10 K | | 01121 | RC07 |
| R 64 | NOT USED | | | |
| R 64A | RES FXD COMP 220 OHM | | 01121 | RC07 |
| R 64B | RES FXD COMP 220 OHM | | 01121 | RC07 |
| R 65 | RES FXD COMP 470 OHM | | 01121 | RC07 |
| R 66 | NOT USED | | | |
| R 67 | RES FXD COMP 10 K | | 01121 | RC07 |
| R 68 | RES FXD COMP 2X2 K | | 01121 | RC07 |
| R 68A | RES FXD COMP SLCD | | 01121 | RC07 |
| R 69 | RES FXD COMP 15 K | | 01121 | RC07 |
| R 70 | RES FXD COMP 100 OHM | | 01121 | RC07 |
| R 71 | RES FXD COMP 220 OHM | | 01121 | RC07 |
| R 72 | RES FXD COMP 33 K | | 01121 | RC07 |
| R 73 | RES FXD COMP 470 OHM | | 01121 | RC07 |
| R 74 | RES FXD COMP 2X2 K | | 01121 | RC07 |
| R 74A | RES FXD COMP SLCD | | 01121 | RC07 |

86-7-86 (SEPT'87)

# Table 6-1 (Continued)

| REF DES | DESCRIPTION | SULZER LABS STOCK NO. | FSCM | MFR PART NO. |
|---|---|---|---|---|
| R 75 | RES FXD COMP 15 K | | 01121 | RC07 |
| R 76 | RES FXD COMP 100 OHM | | 01121 | RC07 |
| R 77 | RES FXD COMP 150 OHM | | 01121 | RC07 |
| R 78 | RES FXD COMP 33 K | | 01121 | RC07 |
| R 79 | RES FXD COMP 470 OHM | | 01121 | RC07 |
| R 80 | RES FXD COMP 2X2 K | | 01121 | RC07 |
| R 81 | RES FXD COMP 15 K | | 01121 | RC07 |
| R 82 | RES FXD COMP 100 OHM | | 01121 | RC07 |
| R 83 | RES FXD COMP 150 OHM | | 01121 | RC07 |
| R 84 | RES FXD COMP 33 K | | 01121 | RC07 |
| R 85 | RES FXD COMP 470 OHM | | 01121 | RC07 |
| R 86 | RES FXD DEP CARB 150 K | | 01295 | CR 1/8 |
| R 87 | RES FXD DEP CARB 249 K | | 01295 | CR 1/8 |
| R 88 | RES FXD DEP CARB 499 K | | 01295 | CR 1/8 |
| R 89 | RES FXD DEP CARB 249 K | | 01295 | CR 1/8 |
| R 90 | RES FXD COMP 470 OHM | | 01121 | RC07 |
| R 91 | RES FXD COMP 100 K | | 01121 | RC07 |
| R 92 | RES FXD COMP 100 K | | 01121 | RC07 |
| R 93 | RES FXD COMP 100 K | | 01121 | RC07 |
| R 94 | RES FXD COMP 100 K | | 01121 | RC07 |
| R 95 | RES FXD COMP 100 K | | 01121 | RC07 |
| R 96 | RES FXD COMP 100 K | | 01121 | RC07 |
| R 97 | RES FXD COMP 470 K | | 01121 | RC07 |
| R 98 | RES FXD COMP 220 OHM | | 01121 | RC07 |
| R 99 | RES FXD COMP 220 OHM | | 01121 | RC07 |
| R 100 | RES FXD COMP 100 OHM | | 01121 | RC07 |
| R 101 | RES FXD COMP 470 K | | 01121 | RC07 |
| R 102 | RES FXD COMP 220 OHM | | 01121 | RC07 |
| R 103 | RES FXD COMP 220 OHM | | 01121 | RC07 |
| R 104 | RES FXD COMP 100 OHM | | 01121 | RC07 |
| S 1 | SWITCH THERMOSTAT | | 80640 | MX-300 |
| S 2 | SWITCH ROTARY | | 81073 | 24002-9 |
| S 3 | SWITCH PUSHBUTTON | | 81073 | 30-1 |
| T 1 | XFMR | S-28062A | 23732 | S-28062A |
| T 2 | XFMR | S-28062B | 23732 | S-28062B |
| T 3 | XFMR | S-28062C | 23732 | S-28062C |
| T 4 | XFMR | S-28062C | 23732 | S-28062C |
| T 5 | XFMR VAR TUNE | 7-30 | 23732 | 7-30 |
| T 6 | XFMR VAR TUNE | 7-40 | 23732 | 7-40 |
| T 7 | XFMR VAR TUNE | 7-110 | 23732 | 7-110 |
| T 8 | XFMR VAR TUNE | 7-140 | 23732 | 7-140 |
| T 9 | XFMR VAR TUNE | 7-220 | 23732 | 7-220 |
| T 10 | XFMR VAR TUNE | 7-220 | 23732 | 7-220 |
| T 11 | XFMR VAR TUNE | 7-30 | 23732 | 7-30 |
| T 12 | XFMR VAR TUNE | 7-30 | 23732 | 7-30 |
| T 13 | XFMR VAR TUNE | 7-30 | 23732 | 7-30 |
| T 14 | XFMR VAR TUNE | 7-60 | 23732 | 7-60 |
| T 15 | XFMR VAR TUNE | 7-60 | 23732 | 7-60 |
| T 16 | XFMR VAR TUNE | 7-60 | 23732 | 7-60 |
| T 17 | XFMR VAR TUNE | 7-180 | 23732 | 7-180 |
| T 18 | XFMR VAR TUNE | 7-180 | 23732 | 7-180 |
| T 19 | XFMR VAR TUNE | 7-180 | 23732 | 7-180 |
| Y 1 | XTAL 5 MHZ | | 71034 | BG61-AH5 |
| Y 2 | XTAL FILTER 5 MHZ | | 06961 | 4051122 5MHZ |
| Y 3 | XTAL FILTER 1 MHZ | | 06961 | 4051122 1MHZ |
| CR 1 | DIODE 1N960B | | 04713 | 1N960B |
| CR 2 | DIODE 1N662 | | 01295 | 1N662 |
| CR 3 | DIODE 1N662 | | 01295 | 1N662 |
| CR 4 | DIODE 1N662 | | 01295 | 1N662 |
| CR 5 | DIODE 1N662 | | 01295 | 1N662 |
| CR 6 | DIODE 1N662 | | 01295 | 1N662 |
| CR 7 | DIODE 1N662 | | 01295 | 1N662 |
| CR 8 | DIODE 1N757A | | 04713 | 1N757A |
| CR 9 | VARICAP | | 01281 | V7E |
| CR 10 | NOT USED | | | |
| CR 11 | NOT USED | | | |
| CR 12 | DIODE 1N662 | | 01295 | 1N662 |
| CR 13 | DIODE 1N662 | | 01295 | 1N662 |
| CR 14 | DIODE 1N662 | | 01295 | 1N662 |
| CR 15 | DIODE IN4384 | | 01295 | 1N4384 |
| HR 1 | HEATER 150 OHM | S-28042B | 23732 | S-28042B |
| HR 2 | HEATER 46 OHM | S-28042A | 23732 | S-28042A |
| MP 1 | GASKET | | 16231 | 2-239 |
| MP 2 | GASKET | | 16231 | 2-23 |
| MP 3 | MOUNT W/TBI | S-18007 | 23732 | S-18007 |
| MP 4 | DRIVE W/C3 | S-38019-1 | 23732 | S-38019-1 |
| MP 5 | SHAFT MP4 | S-18023-1 | 23732 | S-18023-1 |

86-7-86 (SEPT'87)

## Table 6-1 (Continued)

| REF DES | DESCRIPTION | SULZER LABS STOCK NO. | FSCM | MFR PART NO. |
|---|---|---|---|---|
| RT 1 | THERMISTOR | | 83186 | 41A11 |
| RT 2 | THERMISTOR | | 83186 | 41A11 |
| RT 3 | THERMISTOR | | 83186 | 41A11 |
| TB 1 | TERM BRD MP3 | | 82229 | 2785-21-SS1 |

86-7-6B (SEPT'87)

# Table 6-2

## Federal Supply Code for Manufacturers

| CODE NO. | MANUFACTURER | ADDRESS |
|---|---|---|
| 00656 | AEROVOX CORP | NEW BEDFORD, MASS 02741 |
| 01121 | ALLEN-BRADLEY CO | MILWAUKEE, WISC 53204 |
| 01281 | TRW SEMICONDUCTORS INC | LAWNDALE, CALIF 90260 |
| 01295 | TEXAS INSTRUMENTS INC SEMICONDUCTOR-COMPONENTS DIV | DALLAS, TEX 75231 |
| 02111 | SPECTROL ELECTRONICS CORP | CITY OF INDUSTRY, CALIF 91745 |
| 02214 | FERROXCUBE CORP. OF AMERICA | SAUGERTIES, N Y 12477 |
| 02735 | RADIO CORP OF AMER COMML REC TUBE AND SEMICONDUCTOR DIV | SOMERVILLE, N J |
| 04713 | MOTOROLA INC, SEMICONDUCTOR PRODUCTS INC | PHOENIX, ARIZONA 85008 |
| 06961 | PIEZOELECTRIC DIV OF CLEVITE CORP | BEDFORD, O |
| 16231 | PARKER INSTRUMENT CORP | STAMFORD, CONN |
| 23732 | SULZER LABORATORIES DIV TRACOR, INC | LOS ANGELES, CALIF 90045 |
| 38315 | HONEYWELL INC PRECISION METER DIV | MANCHESTER, N H 03105 |
| 56289 | SPRAGUE ELECTRIC CO | NORTH ADAMS, MASS |
| 71034 | BLILEY ELECTRIC CO INC | ERIE, PA |
| 71468 | ITT CANNON ELECTRIC INC | LOS ANGELES, CALIF 90031 |
| 71590 | CENTRALAB DIVISION OF GLOBE-UNION INC | MILWAUKEE, WISC 53212 |
| 73138 | BECKMAN INSTRUMENTS INC HELIPOT DIV | FULLERTON, CALIF 92634 |
| 73899 | JFD ELECTRONICS CORP | BROOKLYN, N Y |
| 76299 | CORNING GLASS WORKS ELECTRONIC COMPONENTS DIV | RALEIGH, N C |
| 80294 | BOURNS INC | RIVERSIDE, CALIF 92506 |
| 80640 | STEVENS ARNOLD INC | SOUTH BOSTON, MASS 02127 |
| 81073 | GRAYHILL INC | LA GRANGE, ILL 60525 |
| 81312 | WINCHESTER ELECTRONICS DIV LITTON INDUSTRIES INC | OAKVILLE, CONN |
| 82229 | HERMETIC SEAL CORP | ROSEMEAD, CALIF 91770 |
| 83186 | VICTORY ENGINEERING CORP | SPRINGFIELD, N J 07081 |
| 83330 | SMITH, HERMAN H INC | BROOKLYN, N Y 11207 |
| 84171 | ARCO ELECTRONICS INC | GREAT NECK, N Y 11022 |
| 94738 | MARTIN H S AND SON | EVANSTON, ILL 60204 |

# SECTION VII
# DRAWINGS AND DIAGRAMS

7-1. SCOPE OF SECTION.

7-2. This section contains the schematic diagram of the frequency standard and an illustration showing the location of the adjustment and calibration points inside the frequency standard. The schematic diagram and illustration are referenced in sections IV (theory of operation) and V (maintenance).

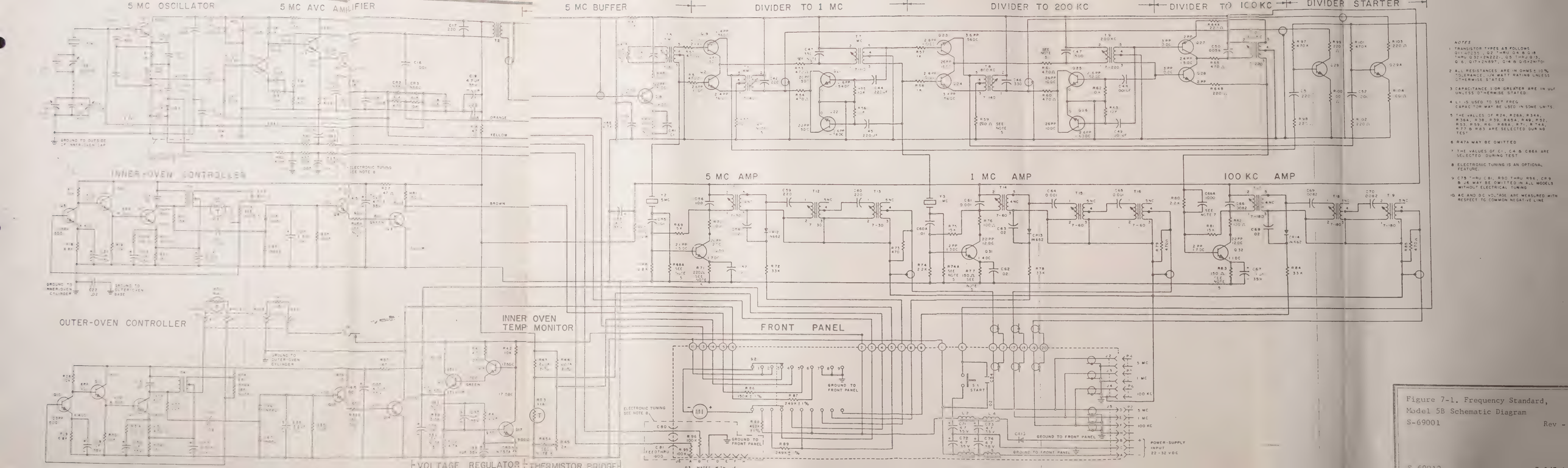
5 MC OSCILLATOR
5 MC AVC AMPLIFIER
5 MC BUFFER
DIVIDER TO 1 MC
DIVIDER TO 200 KC
DIVIDER TO 100 KC
DIVIDER STARTER
INNER-OVEN CONTROLLER
OUTER-OVEN CONTROLLER
INNER OVEN TEMP MONITOR
5 MC AMP
1 MC AMP
100 KC AMP
FRONT PANEL
VOLTAGE REGULATOR
THERMISTOR BRIDGE
NOTES
1. TRANSISTOR TYPES AS FOLLOWS Q1,Q2,Q3,Q5 - 2N2369 OR 2N3563, Q4 - 2N2222, Q6 - 2N2697, Q7 - 2N2894, Q8 - 2N2270
2. ALL RESISTANCES ARE IN OHMS ± 10% TOLERANCE, 1/4 WATT RATING UNLESS OTHERWISE STATED
3. CAPACITANCE VALUES GREATER ARE IN UUF UNLESS OTHERWISE STATED
4. L1 - L5 USED TO SET FREQ. CAPACITOR MAY BE USED IN SOME UNITS.
5. THE VALUES OF R24, R28A, R34A, R36A, R38, R39, R45A, R49, R52, R53, R55, R65, R65A, R71, R74A, R77 & R83 ARE SELECTED DURING TEST
6. R47A MAY BE OMITTED
7. THE VALUES OF C1, C4 & C68A ARE SELECTED DURING TEST
8. ELECTRONIC TUNING IS AN OPTIONAL FEATURE
9. C73 THRU C81, R90 THRU R98, CR9 & J6 MAY BE OMITTED IN ALL MODELS WITHOUT ELECTRICAL TUNING
10. AC AND DC VOLTAGE ARE MEASURED WITH RESPECT TO COMMON NEGATIVE LINE

Figure 7-1. Frequency Standard, Model 5B Schematic Diagram S-69001 Rev -

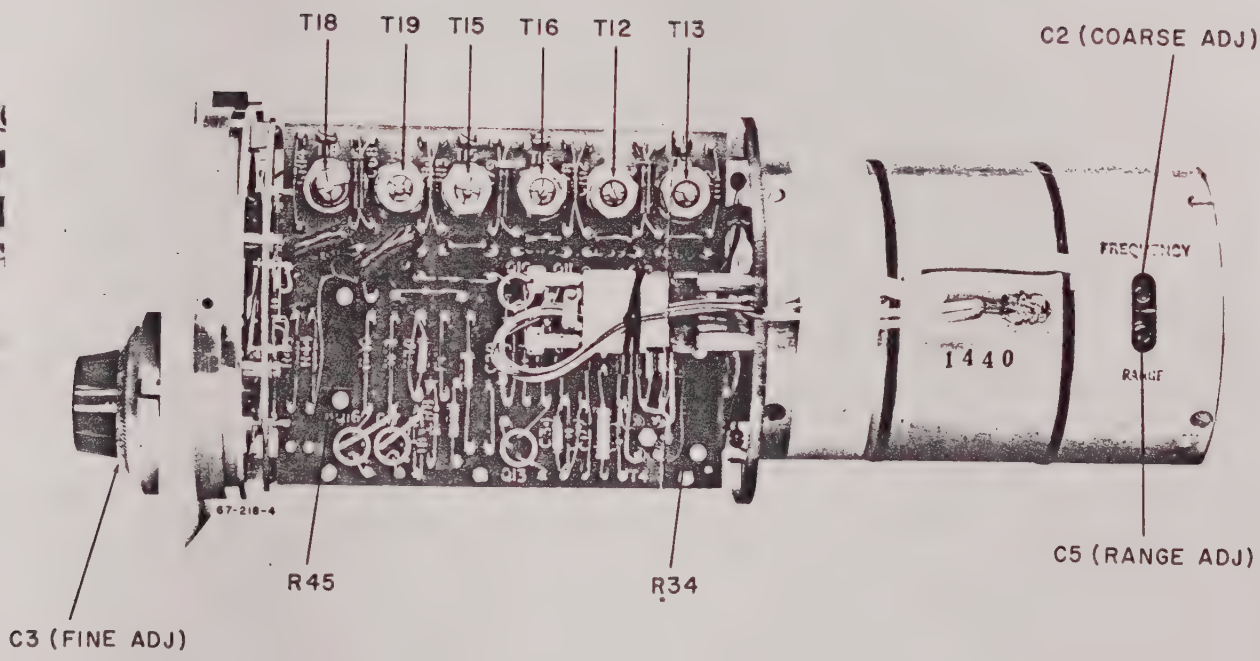


Figure 7-2. Frequency Standard Internal Adjustment Controls.

# APPENDIX A
# SULZER LABORATORIES POWER SUPPLY MODEL 5P
# OPERATION AND SERVICE MANUAL

A-1. INTRODUCTION.

A-2. This appendix contains the operation and service manual for the Power Supply Model 5P manufactured by Sulzer Laboratories Division, TRACOR, Inc.

# OPERATION AND SERVICE MANUAL

# POWER SUPPLY

# MODEL 5P

SERIAL NO. _____ S-69014

September 1967

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TRACOR, Inc.

Information disclosed herein may not be reproduced in any form without express permission of TRACOR, Inc.

## WARRANTY

TRACOR, Inc. warrants each instrument it manufactures to be free from defects in material and workmanship. The obligation under this warranty is limited to repairing or replacing any instrument or part thereof that shall be returned to us by the original purchaser, transportation charges prepaid, when upon examination it is disclosed to our satisfaction to be defective. This warranty is effective for one year after delivery to the original purchaser. If the fault has been caused by misuse or abnormal conditions of operation, repair will be made at cost. In this case, an estimate will be submitted before work is started.

If any fault develops, notify TRACOR, Inc. and give full details, including model and serial numbers. You will then be notified as to the disposition of the defective instrument.

SULZER LABORATORIES DIVISION
9610 Bellanca Avenue
Los Angeles, California 90045
AC 213 / 670-5544

TRACOR

A6-106-76

# INTRODUCTION

This manual contains the information necessary to operate and maintain the Power Supply Model 5P manufactured by Sulzer Laboratories Division, TRACOR, Inc. This information includes physical description, installation procedures, operating procedures, theory of operation, procedures for calibration, a parts list, and applicable drawings and diagrams required to provide adequate manual support.

This manual is to be used by all personnel operating or servicing the Power Supply.

# TABLE OF CONTENTS


| Section | | Page |
|---|---|---|
| I | GENERAL DESCRIPTION | 1-1 |
| | 1-1 Scope of Section | 1-1 |
| | 1-3 Purpose of Equipment | 1-1 |
| | 1-5 Description of Equipment | 1-1 |
| Section II | INSTALLATION | 2-1 |
| | 2-1 Scope of Section | 2-1 |
| | 2-3 Installation | 2-1 |
| | 2-5 Rack Mounting | 2-1 |
| | 2-7 Power connections | 2-1 |
| | 2-9 Operation on 230 Volt AC Power | 2-3 |
| | 2-10 Initial Battery Charge | 2-3 |
| Section III | OPERATION | 3-1 |
| | 3-1 Scope of Section | 3-1 |
| | 3-3 Equipment Turn On | 3-1 |
| | 3-5 Operation | 3-1 |
| | 3-7 Battery Recharge | 3-1 |
| Section IV | THEORY OF OPERATION | 4-1 |
| | 4-1 Scope of Section | 4-1 |
| | 4-3 Functional Analysis | 4-1 |
| | 4-5 Rectifying and Regulating Section | 4-1 |
| | 4-6 Battery Charging Section | 4-2 |
| | 4-7 Battery and Low Voltage Cutoff Section | 4-2 |
| | 4-9 Detailed Theory of Operation | 4-2 |
| | 4-11 Voltage Rectifier | 4-3 |
| | 4-12 Voltage Regulator | 4-3 |

## TABLE OF CONTENTS (Continued)


| | | Page |
|---|---|---|
| 4-14 | Low Voltage Cutoff Circuit..... | 4-3 |
| 4-19 | Normal Charge Circuit..... | 4-4 |
| 4-20 | High Charge Circuit..... | 4-4 |
| Section V | MAINTENANCE..... | 5-1 |
| 5-1 | Scope of Section..... | 5-1 |
| 5-3 | Trouble Analysis..... | 5-1 |
| 5-5 | Maintenance..... | 5-1 |
| Section VI | REPLACEABLE PARTS..... | 6-1 |
| 6-1 | Scope of Section..... | 6-1 |
| 6-3 | List of Replaceable Parts..... | 6-1 |
| 6-5 | Reference Designation..... | 6-1 |
| 6-6 | Part Description..... | 6-1 |
| 6-7 | Sulzer Laboratories Stock Number... | 6-1 |
| 6-8 | Federal Supply Code for Manufacturers.. | 6-1 |
| 6-11 | Ordering Information..... | 6-2 |
| Section VII | DRAWINGS AND DIAGRAMS..... | 7-1 |
| 7-1 | Scope of Section..... | 7-1 |


## LIST OF ILLUSTRATIONS


| Figure | Title | Page |
|---|---|---|
| 1-1 | Power Supply Model 5P..... | 1-2 |
| 2-1 | Rack Panel Mounting Template..... | 2-2 |
| 4-1 | Power Supply Functional Block Diagram..... | 4-1 |
| 7-1 | Power Supply Schematic Diagram S-19002..... | 7-3 |

# LIST OF TABLES


| Table | Title | Page |
|---|---|---|
| 1-1 | Power Supply Controls and Indicators..... | 1-3 |
| 6-1 | List of Replaceable Parts..... | 6-4 |
| 6-2 | Federal Supply Code for Manufacturers..... | 6-5 |

# SECTION I
# GENERAL DESCRIPTION

1-1. SCOPE OF SECTION.

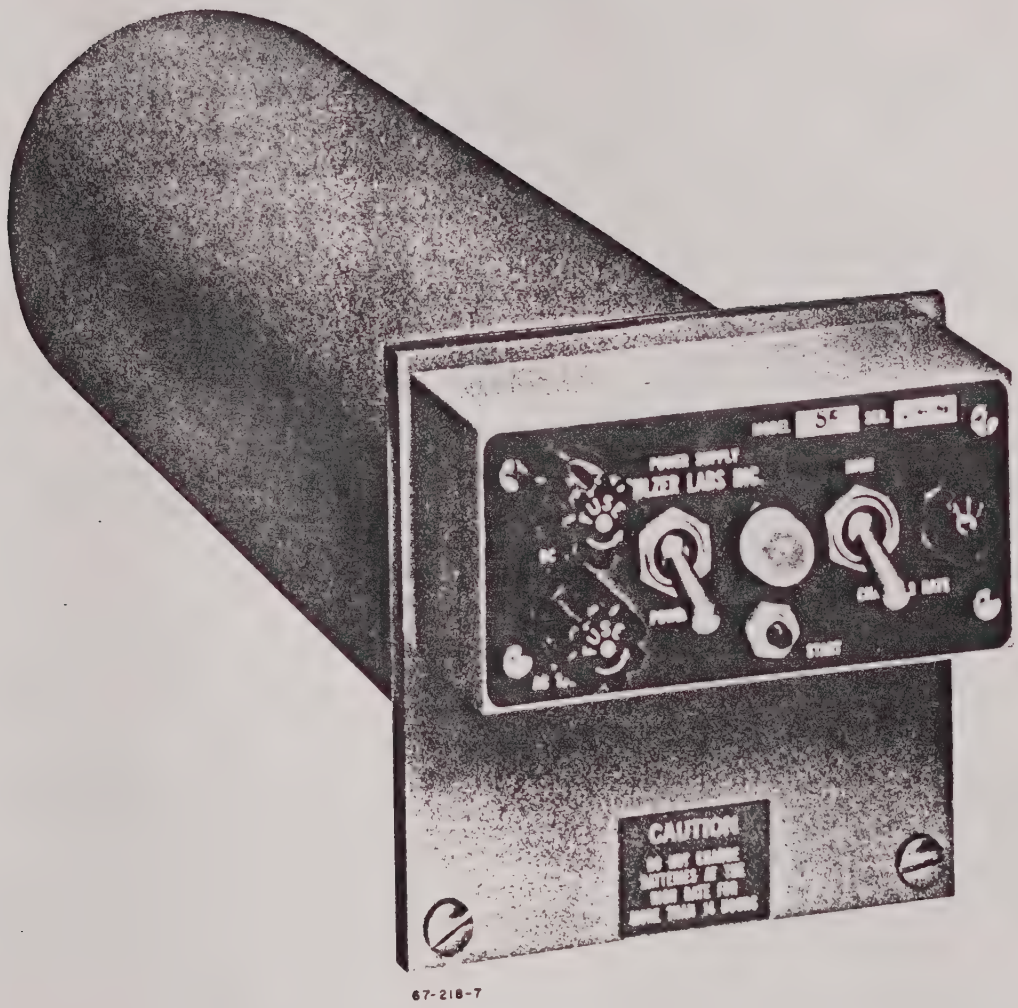
1-2. This section describes the purpose and physical characteristics of the Sulzer Laboratories, Power Supply Model 5P and provides a brief description of the operating controls and indicators.

1-3. PURPOSE OF EQUIPMENT.

1-4. The Power Supply Model 5P provides direct current power, with battery backup, for the Frequency Standard Model 2.5B, Model 2.5C, or Model 5B.

1-5. DESCRIPTION OF EQUIPMENT.

1-6. The power supply (figure 1-1) is 4.5 inches high, 4.5 inches wide, 14.25 inches deep, and weighs approximately 12 pounds. When it is rack mounted with a frequency standard it is 5.25 inches high and 19 inches wide. It contains a rectifying and regulating circuit, a battery charging circuit, a low voltage cutoff circuit, and a 26.5 volt emergency backup battery. Refer to table 1-1 for a functional description of the power supply controls and indicators.




B6-106-92

Figure 1-1. Power Supply Model 5P.

Table 1-1.

Power Supply Controls and Indicators

| Name | Reference Designation | Function |
|---|---|---|
| POWER switch | S1 | Applies 230 or 115 volts ac to rectifier circuit and applies internal battery voltage to regulator circuit. |
| POWER lamp | DS1 | Lights when power supply is connected to ac power and POWER switch is on. |
| CHARGING RATE switch | S2 | In HIGH position, applies rectifier output voltage to battery, through two parallel resistors, to provide 400 milliampere charging rate. |
| HIGH lamp | DS2 | Lights when battery is being charged at 400 milliampere rate. |
| START pushbutton | S3 | Momentarily bypasses battery cutoff circuit to provide dc output when power supply is first turned on and ac power is not present. |

# SECTION II
# INSTALLATION

2-1. SCOPE OF SECTION.

2-2. This section provides instructions for installation of the power supply.

2-3. INSTALLATION.

2-4. Carefully unpack and examine the power supply for possible damage during shipment. Special attention should be given to areas where the outside shipping package was damaged.

2-5. RACK MOUNTING. The power supply can be factory mounted in an optional 19 inch rack panel with a frequency standard. If the power supply is not factory mounted, it can be mounted in any suitable rack panel or cabinet. Refer to figure 2-1 for a template of the panel cutout required to mount the power supply. The power supply fastens to the rack panel with four 10-24 screws in its front panel.

2-6. If the power supply will be used as a mobile unit, the optional rear clamp (part Number S-38181-1) should be used to support the rear of the power supply. The rear clamp must be supported with two side plates fastened between the panel and the rear clamp. The distance the rear clamp is positioned from the panel is not critical and can be changed to meet different mounting requirements.

2-7. POWER CONNECTIONS. The power supply, when factory mounted with the frequency standard, should be already connected to the frequency standard. Check that power supply cable is securely connected to connector J5 on rear of frequency standard.

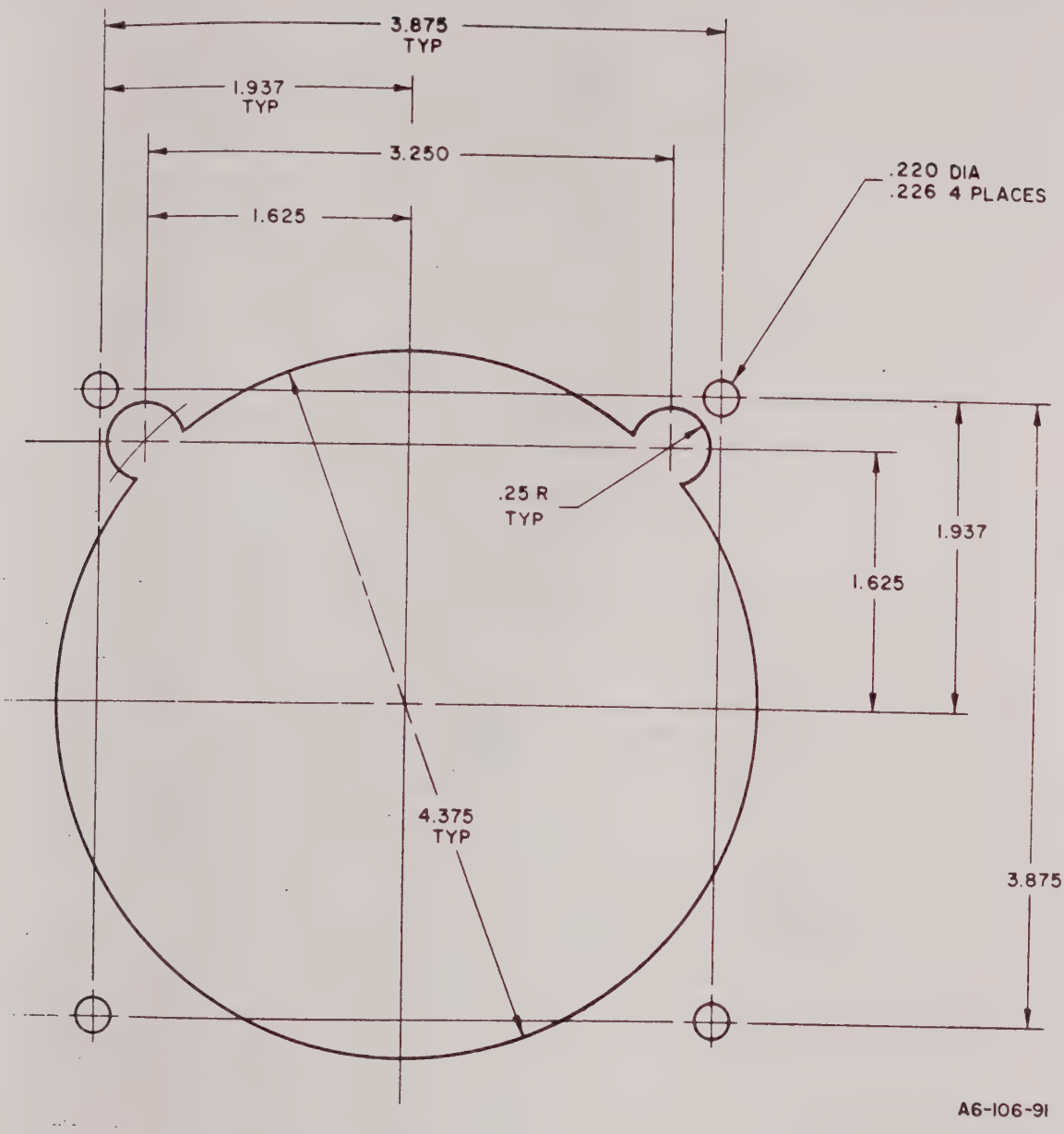



Figure 2-1. Rack Panel Mounting Template.

2-8. If the power supply is not factory mounted, the power supply cable supplied must be connected between the frequency standard and the power supply.

2-9. OPERATION ON 230 VOLT AC POWER. The power supply is factory wired for operation on 115 volt ac power, but can be modified to operate on 230 volt ac power. Modify the power supply as follows:

a. Remove outer cylindrical container from power supply.
b. Remove jumper connected between terminals 1 and 3 on transformer T1.
c. Remove jumper connected between terminals 2 and 4 on transformer T1.
d. Connect jumper between terminals 2 and 3 on transformer T1.
e. Reassemble power supply.
f. Mark outside of power supply near facility power cord as follows: THIS UNIT WIRED FOR 230 VOLT OPERATION.

2-10. INITIAL BATTERY CHARGE. The power supply is shipped with the battery discharged 70 percent. Initially recharge the battery as follows:

CAUTION

Do not charge the battery at the high rate for longer than 14 hours. This causes excessive outgassing, reducing the electrolyte level enough to cause the battery to fail.

a. Set CHARGING RATE switch to HIGH. HIGH lamp shall light.
b. Allow battery to charge at high rate for 10 hours.
c. Set CHARGING RATE switch to normal position. HIGH lamp shall go out.

**NOTE**

The power supply can be used to provide power for the frequency standard while the battery is being recharged.

2-11. Power supply is now ready for use.

# SECTION III
# OPERATION

3-1. SCOPE OF SECTION.

3-2. This section provides detailed procedures for operation of the power supply.

3-3. EQUIPMENT TURN ON.

3-4. Turn on power supply as follows:

a. Connect power supply to ac facility power.

b. Set POWER switch on. POWER lamp will light.

c. Check that CHARGING RATE switch is not in HIGH position and that HIGH lamp is not lighted.

3-5. OPERATION.

3-6. The power supply does not require operation procedures after turn on. If ac power is lost, the power supply will automatically switch to its internal battery. The battery will provide power for the frequency standard for a minimum of 10 hours at 25 degrees C.

3-7. BATTERY RECHARGE. The battery charging circuit will automatically recharge the battery when ac power is restored.

3-8. If the battery has been used for more than 2.5 hours recharge the battery at the high rate for 4 hours as follows:

CAUTION

Do not charge the battery at the high rate for longer than 14 hours. This causes excessive outgassing, reducing the electrolyte level enough to cause the battery to fail.

a. Set CHARGING RATE switch to HIGH. HIGH lamp shall light.

b. Allow battery to charge at high rate for 4 hours.

c. Set CHARGING RATE switch to normal position. HIGH lamp shall go out.

**NOTE**

The power supply can be used to provide power for the frequency standard while the battery is being recharged.

3-9. If the battery has been used until the cutoff circuit disconnects the battery from the load, recharge the battery at the high rate as specified in paragraph 3-8 for 14 hours instead of 4 hours.

3-10. If the power supply will be used as a mobile unit, the battery should be charged at the high rate as specified in paragraph 3-8 before ac power is removed. This will insure that maximum capacity can be supplied by the battery.

# SECTION IV
# THEORY OF OPERATION

4-1. SCOPE OF SECTION.

4-2. This section provides a general description of the overall operation of the power supply and detailed analysis of its individual circuits.

4-3. FUNCTIONAL ANALYSIS.

4-4. The power supply can be divided into three main operational sections; the rectifying and regulating section, the battery charging section, and the battery and low voltage cutoff section. Refer to figure 4-1 for a functional block diagram and to figure 7-1 for a schematic diagram of the power supply.

4-5. RECTIFYING AND REGULATING SECTION. The rectifying and regulating section consists of an input power transformer, a diode bridge, and a voltage regulator. The bridge converts 115 volts ac, or 230 volts ac, to approximately 37 volts dc.

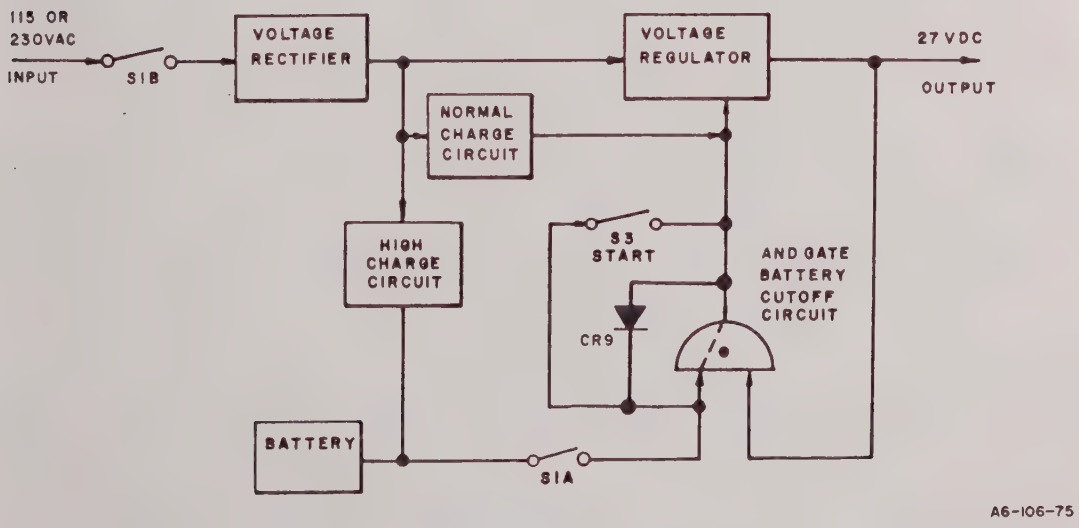



Figure 4-1. Power Supply Functional Block Diagram.

The voltage regulator stabilizes this voltage using the battery voltage as a reference. The 27 volt output of the voltage regulator is used as the power supply output.

4-6. BATTERY CHARGING SECTION. The battery charging section consists of two battery charging circuits, a normal charge circuit and a high charge circuit. The normal charge circuit is always connected to the battery and maintains a 50 milliampere charge current on the battery at all times until the battery is fully charged. The high charge circuit can be manually switched on between the rectifier output and the battery. This circuit produces a 400 milliampere charge current. This is only used after the battery has been used for more than 2.5 hours or before the power supply will be used where ac power is not available.

4-7. BATTERY AND LOW VOLTAGE CUTOFF SECTION. The battery and low voltage cutoff section consists of a 21 cell, 26.5 volt, sealed nickel cadmium battery and its associated low voltage cutoff circuit. The battery supplies the reference for the voltage regulator to provide a stable dc output when ac power is being used. If ac power is lost, the battery provides the dc output, through the voltage regulator.

4-8. The low voltage cutoff circuit contains a relay that deenergizes when the battery voltage drops below 21 volts. This disconnects the battery from the voltage regulator to prevent the battery from reversing its potential when it is discharged. The circuit also has a bypass switch that energizes the low voltage cutoff relay. This allows the battery to be used when ac power is not present to apply the dc power to the frequency standard. However, this will not function if the battery voltage is below 21 volts.

4-9. DETAILED THEORY OF OPERATION.

4-10. The power supply contains a voltage rectifier, a voltage regulator, a battery, a low voltage cutoff circuit, a normal charge circuit, and a high charge circuit.

4-11. VOLTAGE RECTIFIER. The voltage rectifier converts the 115 volt ac input power, coupled through power transformer T1, to 27 volts dc power. The rectifier bridge consists of diodes CR1, CR2, CR3, and CR4. Capacitor C1 across the bridge output reduces ripple. This output is used by the voltage regulator and the normal and high charge circuits.

4-12. VOLTAGE REGULATOR. The voltage regulator, transistor Q1, stabilizes the rectifier output at 27 volts dc. The voltage rectifier output is applied to the collector of transistor Q1 as the voltage regulator input. The voltage regulator output at the emitter of transistor Q1 is controlled by the dc current from the battery. The current is applied to the base of transistor Q1 through diode CR7. If the voltage regulator output is low, the base current of transistor Q1 increases. By increasing the base current, the voltage drop across transistor Q1 decreases. This increases the voltage regulator output.

4-13. If ac power is lost, the battery supplies dc power, through the base of transistor Q1, to the power supply output. Since the base emitter junction of transistor Q1 is always forward biased, there is no switching transient from ac to battery power.

4-14. LOW VOLTAGE CUTOFF CIRCUIT. The low voltage cutoff circuit consists of relay K1, transistor Q3, zener diode CR8, and the voltage divider network consisting of resistors R6 and R8 and potentiometer R7.

4-15. The battery voltage is applied to the voltage divider network and to the normally open contact of relay K1. Potentiometer R7 selects a portion of the battery voltage dropped across the divider network and applies it to zener diode CR8. Potentiometer R7 is adjusted so that zener diode CR8 conducts as long as the battery voltage is greater than 21 volts. When zener diode CR8 conducts, transistor Q3 turns on, applying a ground to the coil of relay K1. The voltage regulator output energizes

relay K1, which applies the battery voltage to the voltage regulator.

4-16. When ac power is lost, the battery power, through the voltage regulator, keeps relay K1 energized. As the battery discharges its voltage decreases. When the battery voltage decreases to 21 volts, zener diode CR8 stops conducting, transistor Q3 turns off, and relay K1 deenergizes. This removes the battery power from the voltage regulator.

4-17. When the power supply is used where ac power is not available, START switch S3 is used to bypass relay K1 contacts. This applies the battery power to the voltage regulator which energizes relay K1. The circuit then functions as stated in paragraphs 4-15 and 4-16.

4-18. Diode CR5 prevents the battery voltage from lighting the POWER lamp, which would use a portion of the battery capacity. Diode CR9 is an arc suppression diode that protects the contacts of relay K1.

4-19. NORMAL CHARGE CIRCUIT. The normal charge circuit provides a 50 milliampere charging current to recharge and to maintain the battery at full capacity. It consists of transistor Q2 resistors R3 and R4, and diode CR6. Transistor Q2 regulates the charging current being applied to the battery. Zener diode CR6 maintains the correct potential across the charger circuit, which is approximately 5 volts dc.

4-20. HIGH CHARGE CIRCUIT. The high charge circuit provides a 400 milliampere charging current to recharge the battery after it has been used for more than 2.5 hours. CHARGING RATE switch S2 switches two parallel connected resistors into the circuit between the voltage rectifier output and the battery. These two resistors, R5A and R5B, regulate the charging current at 400 milliamperes. Diode CR10 prevents the charging circuit from discharging the battery, through HIGH lamp DS2, if the CHARGING RATE switch is set to HIGH while the battery output is being used.

# SECTION V
# MAINTENANCE

5-1. SCOPE OF SECTION.

5-2. This section provides all procedures required to maintain the power supply.

5-3. TROUBLE ANALYSIS.

5-4. Because of the simplicity of the design of the power supply, trouble analysis procedures are not required. Refer to the schematic diagram (figure 7-1) to aid in trouble shooting if the power supply does not operate properly.

5-5. MAINTENANCE.

5-6. To insure reliable operation the battery should be replaced once a year. The battery is a sealed unit and cannot be serviced; if it does not produce the specified capacity, it should be replaced.

**WARNING**

The safety vents on the battery must never be plugged or covered. This can cause pressure buildup in the battery as it outgasses during its charge cycle. Excessive pressure buildup can cause the battery to explode.

5-7. The power supply requires no other maintenance.

# SECTION VI
# REPLACEABLE PARTS

6-1. SCOPE OF SECTION.

6-2. This section provides all necessary information for quick identification of replaceable parts for the power supply. The section contains a list of replaceable parts and a numeric list of federal supply codes for manufacturers.

6-3. LIST OF REPLACEABLE PARTS.

6-4. A list of replaceable parts for the power supply is presented in table 6-1. Information in the table includes the reference designation, part description, Sulzer Laboratories stock number, federal supply code for manufacturers (FSCM), and manufacturer part number, presented in that order.

6-5. REFERENCE DESIGNATION. The reference designation is an alpha-numeric identification assigned to each assembly and to electrical components within an assembly. Reference designations are obtained by referring to the schematic diagram (figure 7-1) or by markings on the assembly.

6-6. PART DESCRIPTION. All parts are described using the noun-modifier method. For example, a 2500 ohm variable resistor is described as: RES VAR 2X5 K. The "X" between the "2" and the "5" represents the position of the decimal.

6-7. SULZER LABORATORIES STOCK NUMBER. A Sulzer Laboratories stock number is assigned to replaceable parts in the power supply. Identical parts have identical stock numbers. Presently, only replaceable parts manufactured or assembled by Sulzer Laboratories have a stock number assigned to them.

6-8. FEDERAL SUPPLY CODE FOR MANUFACTURERS.

6-9. A list of manufacturers supplying parts for the power supply is provided in table 6-2. Information in the table includes the manufacturer federal supply code number, manufacturer's name, and manufacturer's address, presented in that order. The manufacturers are listed in numerical order by

federal supply code number.

6-10. To locate the manufacturer of a part, proceed as follows:

a. Obtain the manufacturer federal supply code number by referring to the List of Replaceable Parts (table 6-1).

b. Locate the federal supply code number in the appropriate column of the Federal Supply Code for Manufacturers (table 6-2).

6-11. ORDERING INFORMATION.

6-12. Address orders or inquiries to either an authorized Sulzer Laboratories Sales Representative or to:

Customer Service
Sulzer Laboratories Division,
TRACOR, Inc.
9610 Bellanca Avenue
Los Angeles, California 90045

6-13. To insure prompt service, orders must include the following information:

a. Name, model, and serial number of the instrument.

b. Reference designation, if applicable.

c. Sulzer Laboratories stock number, if one is assigned.

d. Full description of the part.

6-14. Item a. is located on the instrument; and items b., c., and d. are found in the List of Replaceable Parts (table 6-1).

6-15. The part numbers shown will change occasionally as manufacturers' items are reevaluated or as improved components become available. The component shipped will be the component used in production at the time the order is received, and will be equivalent to the component it replaces in both dimensions and performance.

6-16. The minimum billing on any order is $15.00, with a standard delivery of 30 days. All prices are FOB Los Angeles, California, and are subject to change without notice.

# Table 6-1
## List of Replaceable Parts

| REF DES | | DESCRIPTION | SULZER LABS STOCK NO. | FSCM | MFR PART NO. |
|---|---|---|---|---|---|
| C | 1 | CAP ELEC 300 MFD | | 00656 | CE51C301G |
| F | 1 | FUSE SLOW .5 AMP | | 71400 | |
| F | 2 | FUSE FAST 1 AMP | | 71400 | |
| K | 1 | RELAY DPDT 5 K | | 02288 | JSH-6D |
| Q | 1 | TSTR NPN 2N1701 | | 02735 | 2N1701 |
| Q | 2 | TSTR NPN 2N1701 | | 02735 | 2N1701 |
| Q | 3 | TSTR NPN 2N697 | | 01295 | 2N697 |
| R | 1 | RES FXD COMP 680 OHM | | 01121 | RC32 |
| R | 2 | RES FXD COMP 680 OHM | | 01121 | RC32 |
| R | 3 | RES FXD COMP 1 K | | 01121 | RC32 |
| R | 4 | RES FXD COMP 100 OHM | | 01121 | RC42 |
| R | 5 | RES FXD WW SLCD | | 14841 | 10XM20 |
| R | 6 | RES FXD WW 6X8 K | | 14841 | RC07 |
| R | 7 | RES VAR 2X5 K | | 12697 | 48M9-2500 |
| R | 8 | RES FXD WW 4X7 K | | 01121 | RC07 |
| R | 9 | RES FXD WW 10 K | | 01121 | RC07 |
| S | 1 | SWITCH TOGGLE DPST | | 31356 | ST22K |
| S | 2 | SWITCH | | 81073 | 30-1 |
| S | 3 | SWITCH TOGGLE DPST | | 31356 | ST22K |
| T | 1 | XFMR | 6-R1A | 23732 | 6-R1A |
| BA | 1 | NI-CAD BATTERY PACK | BA-1 | 23732 | BA-1 |
| CR | 1 | DIODE 1N4384 | | 01295 | 1N4384 |
| CR | 2 | DIODE 1N4384 | | 01295 | 1N4384 |
| CR | 3 | DIODE 1N4384 | | 01295 | 1N4384 |
| CR | 4 | DIODE 1N4384 | | 01295 | 1N4384 |
| CR | 5 | DIODE 1N4384 | | 01295 | 1N4384 |
| CR | 6 | DIODE 1N751A | | 01295 | 1N751A |
| CR | 7 | DIODE 1N4384 | | 01295 | 1N4384 |
| CR | 8 | DIODE 1N960 | | 01295 | 1N960 |
| CR | 9 | DIODE 1N4384 | | 01295 | 1N4384 |
| DS | 1 | LAMP MINAT 28 V | | 71744 | 327 |
| DS | 2 | LAMP MINAT 28 V | | 71744 | 327 |
| MP | 1 | NOT USED | | | |
| MP | 2 | GASKET | | 16231 | 2-237 |
| MP | 3 | GASKET | | 16231 | 2-23 |
| MP | 4 | MOUNT TB1 | S-18007 | 23732 | S-18007 |
| TB | 1 | HEADER | | 82229 | 2785-21-SS1 |
| XC | 1 | XTAL SOCKET | | 91662 | TS 101P01 |
| XF | 1 | FUSEHOLDER | | 75915 | 342004 |
| XF | 2 | FUSEHOLDER | | 75915 | 342004 |
| XDS | 1 | LAMPHOLDER WHT LENS | | 72619 | 101-3830-935 |
| XDS | 2 | LAMPHOLDER RED LENS | | 72619 | 101-3830-931 |

86-7-86 (SEPT 87)

# Table 6-2

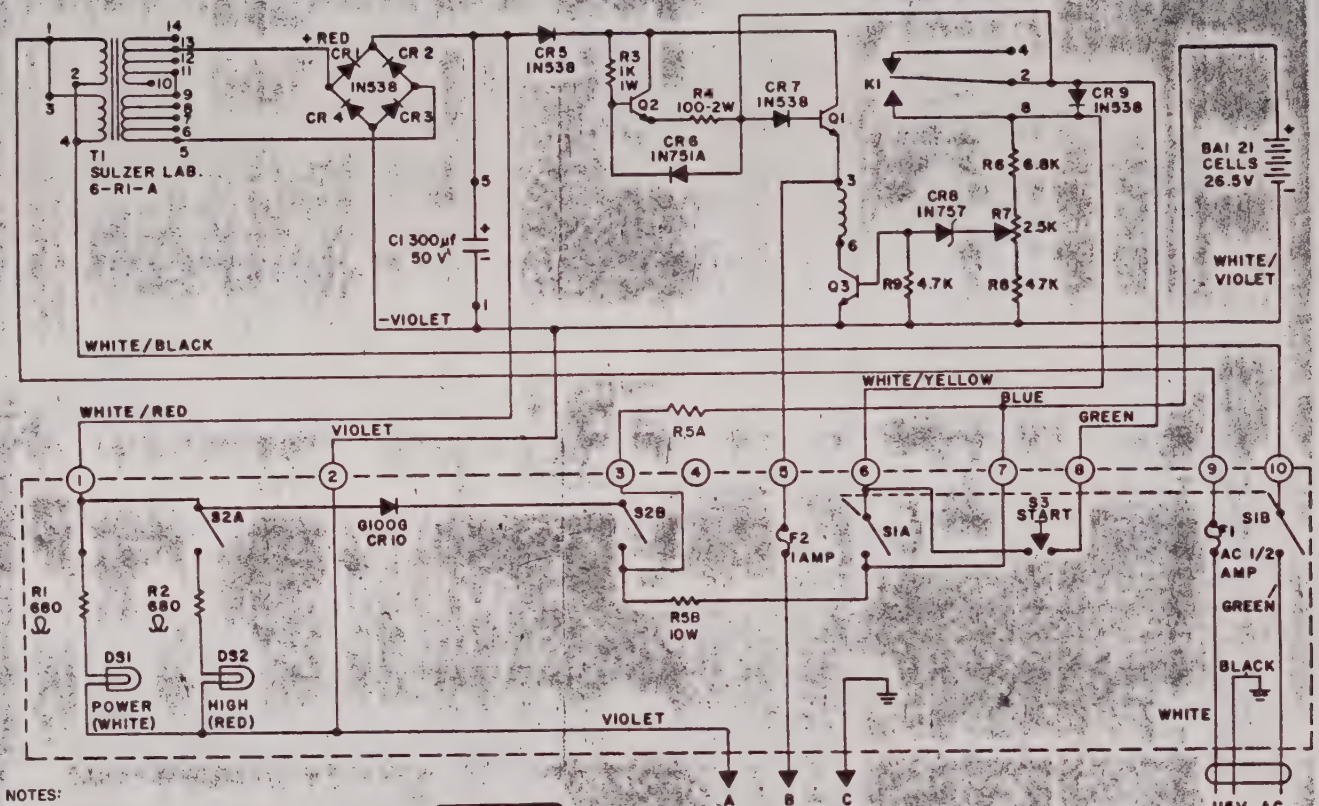
## Federal Supply Code for Manufacturers

| CODE NO. | MANUFACTURER | ADDRESS |
|---|---|---|
| 00656 | AEROVOX CORP | NEW BEDFORD MASS 02741 |
| 01121 | ALLEN-BRADLEY CO | MILWAUKEE, WISC 53204 |
| 01295 | TEXAS INSTRUMENTS INC SEMICONDUCTOR-COMPONENTS DIV | DALLAS, TEX 75231 |
| 02288 | ALLIED CONTROL CO INC | PLANTSVILLE, CONN 10021 |
| 02735 | RADIO CORP OF AMER COMML REC TUBE AND SEMICONDUCTOR DIV | SOMERVILLE, N J |
| 12697 | CLAROSTAT MFG CO INC | DOVER, N H 03820 |
| 14841 | WARD LEONARD ELECTRIC CO | HAGERSTOWN, MD 21741 |
| 16231 | PARKER INSTRUMENT CORP | STAMFORD, CONN |
| 23732 | SULZER LABORATORIES DIV TRACOR INC | LOS ANGELES, CALIF 90045 |
| 31356 | JBT INSTRUMENTS INC | NEW HAVEN, CONN 06508 |
| 71400 | BUSSMANN MFG DIV OF MCGRAW-EDISON CO | ST. LOUIS, MO |
| 71744 | CHICAGO MINIATURE LAMP WORKS | CHICAGO, ILL 60640 |
| 72619 | DIALIGHT CORP | BROOKLYN, N Y |
| 75915 | LITTELFUSE INC | DES PLAINES, ILL 60016 |
| 81073 | GRAYHILL INC | LA GRANGE, ILL 60525 |
| 82229 | HERMETIC SEAL CORP | ROSEMEAD, CALIF 91770 |
| 91662 | ELCO CORP | WILLOW GROVE, PA |

# SECTION VII
# DRAWINGS AND DIAGRAMS

7-1. SCOPE OF SECTION.

7-2. This section contains the schematic diagram of the power supply. The schematic diagram is referenced in sections IV (theory of operation) and V (maintenance).




NOTES:
1. R7 ADJUSTED TO CUT OUT AT 21 VOLTS.
2. Q1, Q2 2N 1485 OR 2N 1701.
3. Q3 2N 697.
4. CR7 MAY BE OMMITTED.
5. R5B SELECTED 200HMS APPROXIMATELY.
6. R5A SELECTED VALUE.

K1
1 2 3 4
5 6 7 8

Figure 7-1. Power Supply, Model 5P Schematic Diagram
S-19002 Rev -

S-69014 7-3/7-4

TUCKER
ELECTRONICS · COMPANY

# January 1986
# INVENTORY UPDATE

This update lists most recent additions to our ever-growing test equipment inventory. If you have specific test equipment needs or specifications, please call our Sales Engineers at the numbers shown. You will receive the Tucker Electronics 1986 Full-Line Catalog in April.

AC/DC
EL750 ELECTRONIC LOAD.....$ 850.00
Power loading, 750 W max. Voltage loading, 50 VDC max, 2 VDC min. Current loading, 150 A. Operates in constant current or constant resistance mode.

AILTECH
126 POWER SIGNAL SOURCE.....$ 4,850.00
2-8 GHz, +/- 2%. Outputs 3 W at 2 GHz, 6 W at 2.5-4 GHz, and 0.5 W at 8 GHz.
NM17/27A EMI/FIELD INTENSITY METER.....$16,150.00
Covers 10 kHz to 32 MHz. 100 Hz, 1 kHz, 10 kHz, and 50 kHz bandwidths.
NM37/57A EMI/FIELD INTENSITY METER.....$17,550.00
Covers 30 MHz to 1 GHz. 10 kHz, 100 kHz, and 1 MHz bandwidths.

ARRA
1114-30 DIRECTIONAL COUPLER.....$ 225.00
250 to 500 kHz. 30 dB coupling. N(F) connector.

ASSOCIATED RESEARCH
4271 AC HYPOT.....$ 750.00
0-10 kV, continuously adjustable.

BALLANTINE
314A AC VTVM.....$ 400.00
1 mV to 1000 V; 15 Hz to 6 MHz.

BIOMATION
1650D RECORDER.....$ 4,500.00
Signal inputs 16 channels, 50 MHz. Memory 16 x 512 bits. Internal or external clock.

BLUE M ELECTRIC
ESP350A1 TEMPERATURE CHAMBER.....$ 550.00
Temperature to 204 degrees C. Oven dimensions (WxDxH) 13x12x12 inches. Includes Power-O-Matic 60 Control and Oven Temperature Protection.

BIRD
8130 LOAD RESISTOR.....$ 80.00
DC-4 GHz, 50 W continuous duty, N(F).
8325 ATTENUATOR.....$ 375.00
DC-500 MHz. Power rating of 500 W CW. VSWR 1.1 max. N(F) connectors.
8401 TERMINATION.....$ 225.00
DC-3 GHz. Power rating of 600 W CW. N(F) connector.

BRUEL & KJAER
1405 RANDOM NOISE GENERATOR.....$ 1,395.00
White noise in 20 Hz to 100 kHz range; pink noise in 20 Hz to 50 kHz range. Output 0-3.16 V RMS.
2203 SOUND LEVEL METER.....$ 1,400.00
Battery operated, sound and vibration measurement unit. Measurement range depends on microphone used.

BRUEL & KJAER
2306 RECORDER.....$ 2,625.00
Battery operated log recorder for AC signals (1.6 Hz to 20 kHz) plus DC log and linear recording.
4230 SOUND LEVEL CALIBRATOR.....$ 225.00
Sound level 94 dB re 20 μPa +/- 0.25 dB. Frequency 1 kHz sine. Pocket-sized, battery operated. Fits 1/2 and 1 inch microphones.

BRUSH
220 PORTABLE DUAL CHANNEL RECORDER.....$ 2,400.00
Pressurized ink system with chart speeds of 1, 5, 25, 125 mm/sec.

BOONTON ELECTRONICS
1020 PROGRAMMABLE
FM/AM/PHASE MODULATION SIGNAL GENERATOR.....$ 9,995.00
150 kHz to 540 MHz. RF output of -146.9 dBm to +7 dBm. Resolution of 0.1 dB. Stores/recalls up to 250 front-panel settings.
103C AM/FM SIGNAL GENERATOR.....$ 4,550.00
125 kHz to 175 MHz in 11 bands, selectable resolution. Output of -130 dBm to +23 dBm.
103C/04 AM/FM SIGNAL GENERATOR.....$ 4,650.00
Same specs as 103C. Option 04 is fused RF output.
103D AM/FM SIGNAL GENERATOR.....$ 5,500.00
Same as 103C with addition of phase-lock feature.
103D/04/13/19
FM/AM SIGNAL GENERATOR.....$ 5,995.00
Same specs as 103D. Option 04 adds fused RF output; Option 13 is 75 μsec pre-emphasis; and option 19 is FM distortion 0.05% THD 76-108 MHz.
42AD MICROWATTMETER.....$ 1,100.00
200 kHz to 12.4 GHz, 10 nW to 10 mW (7 ranges).
63B INDUCTANCE BRIDGE.....$ 4,775.00
0.4-20 kHz, 0-11 h, 0.01 ohm to 110 K ohms.
77B 1 MHz BRIDGE.....$ 3,500.00
Measures C (0.0001 pF to 1000 pF), L (25 μh to ∞, G (0 to 1000 micromhos), and R (1000 ohms to 100 Megohms).

B & K/DYNASCAN
1640 POWER SUPPLY.....$ 165.00
11-15 VDC, 0-3 A, regulation of 0.8%. Metered. Input of 115/230 VAC, 60 Hz.

BANG & OLUFSEN
AM1
LF WATTMETER/VOLTMETER (AUDIO MONITOR).....$ 475.00
Measures 10 nW to 140 W in 9 ranges; AC voltage from 300 μV to 37 V in 9 ranges. 4 Hz to 500 kHz.
NM1 SIGNAL/NOISE METER.....$ 1,295.00
Accepts DIN, IEC, CCIR, IHF, JIS, ANSI, and most exsisting standards. Four built-in filters plus external filter hook-up. AF voltmeter measures 20 μV to 370 VAC; Wattmeter, 0.01 nW to 1000 W.

* PRICE SUBJECT TO CHANGE WITHOUT NOTICE.
* ALL INSTRUMENTS ARE SUBJECT TO PRIOR SALE.
* FOR TERMS AND CONDITIONS OF SALE, PLEASE SEE PAGE vi OF THE 1985 TUCKER ELECTRONICS FULL-LINE CATALOG.

CALIFORNIA INSTRUMENTS
1001T POWER SOURCE.....$ 2,900.00
Output of 0-30/75/135 and 270 V determined by plug-in card. Frequency of 45 Hz to 5 kHz determined by plug-in oscillator utilized. Output power 1000 VA at 105-135 V RMS, +/-0.7 power factor.

CUSHMAN
CE3 COMMUNICATINS MONITOR.....$ 2,800.00
Direct reading over 20-80 MHz, 120-180 MHz, and 450-512 MHz bands. Measures FM deviation and frequecy. Generates CW or FM signals (0-1, 1-10, 10-100 µV); audio and IF frequencies (1 kHz to 4 MHz, 1 V).

ELGAR
251 AC POWER SOURCE.....$ 995.00
0-32 V, 0-130 V, 0-260 VAC; 250 VA; single phase.

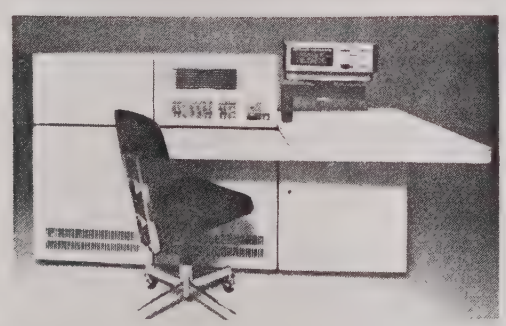
ELECTRONIC MEASUREMENT
ATR100-1 POWER SUPPLY.....$ 165.00
0 to 8, 18, or 32 VDC. 10, 5, or 3 A max. 0.01% regulation. CV/CC, metered.
TO60-1.5M POWER SUPPLY.....$ 300.00
0-60 V, 1.5 A, regulation 10 mV. Metered.
TP050-1M POWER SUPPLY.....$ 250.00
0-50 V, 1 A, regulation 0.1%. Metered.
TR018-1MB POWER SUPPLY.....$ 150.00
0-18 V, 1 A, regulation 0.04%. CV/CC, Metered.
TR036-0.5 POWER SUPPLY.....$ 175.00
0-36 V, 0.5 A, regulation 0.04%. CV/CCC, Unmetered.

ELECTRONIC NAVIGATION INDUSTRIES
503L RF POWER AMPLIFIER.....$ 1,025.00
Covers 2-510 MHz, 40 dB gain, 3 W linear output.

ELECTRO-SCIENTIFIC INDUSTRIES
SC1000 STANDARD CAPACITOR.....$ 950.00
1000 pF with 20 ppm nominal accuracy.

FAIRCHILD ELECTRO-METRICS
EMC25 RECEVIER.....$ 12,200.00
14 kHz to 1000 MHz, 150 dB dynamic range. Choice of wideband or four bandwidths. Measures AM or FM percentage. Outputs for X-Y, recording, linear IF, AM video, FM video, impulse generator, and audio. Battery or AC powered.

FLUKE COMPANY, JOHN
1910A FREQUENCY COUNTER.....$ 395.00
7-digit unit. Measures frequencies up to 125 MHz, period of signals to 2 MHz, period average to 10 ps resolution and totalized to 9,999,999 counts.



FLUKE 7405A/100/120/150/200/300/500/520
AUTOMATED CALIBRATION SYSTEM.....$59,750.00
Fully-loaded calibration system complete with software and instruction/maintenance manuals.

8010A DIGITAL VOLTMETER.....$ 209.00
Measures DC from +/- 200 mV to 1000 V (5 ranges); AC 200 mV to 750 V (5 ranges), and DC current 200 µA to 10 A (6 ranges).
8050A DIGITAL MULTIMETER.....$ 292.00
DC ranges of +/- 200 mV, and +/- 2/200/1000 V. AC ranges of 200 mV to 750 V. Resistance range of 200 ohms to 20 Megohms.

F.W. BELL
620 GAUSSMETER.....$ 1,150.00
Field range 0.1 G (10 testa) to 3 KG (3 testa) full scale. Accuracy +/- 1%.

GENERAL RADIO
1309A OSCILLATOR.....$ 450.00
10 Hz to 100 kHz, 0.05% distortion, 5 V sine or square wave output, 60-dB step attenuator.
1433U DECADE.....$ 595.00
111.1 ohms in 0.01-ohm steps. Four decades.
1434B DECADE.....$ 600.00
1,111,110 in 1-ohm steps. Six decades.
1641 SWEEP FREQUENCY REFLECTOMETER.....$ 1,975.00
20 MHz to 18 GHz in three overlapping ranges. Direct reading in SWR and loss.
1644A MEGOHM BRIDGE.....$ 1,575.00
Measures 10 to the 3rd ohms to 10 to the 15th ohms with 1% accuracy. Seven test voltages.
1650B RLC BRIDGE.....$ 795.00
Measures 1 milliohm to 11 Megohms; 1 pF to 1100 uF, 1 uh to 1100 h, D, and Q with 1% accuracy.
1687B RLC MEGAHERTZ DIGIBRIDGE.....$ 3,000.00
Tests R, L, C, G, D, and Q at 1 MHz, as well as reactance, and susceptance. Remote programmable. Auto binning, 3 test voltages, 2 test speeds.

GERTSCH (SINGER)
FM10CS COMMUNICATIONS MONITOR.....$ 6,375.00
10 KHz to 512 MHz, calibrated output of 0 to -110 dBm (1-db steps). AM measurement (95%), AM generation (95%), Test tones of 400 Hz and 1kHz. Includes RFM10D and OAM1 modules.

GOULD
OS1100A PORTABLE OSCILLOSCOPE.....$ 450.00
DC-30 MHz, dual trace, 1 mV to 10 V/div. Display modes CH1, CH2, CH1 & CH2, CH1 +/-CH2, X-Y. Horizontal timebase ranges 0.2 µsec to 2 sec/cm.
2220 BUG HOUND.....$ 750.00
Microvoltmeter, conductivity, and signal trace modes.

HALCYON
803A DATA LINK ANALYZER.....$ 7,795.00
Uses straight-forward programming language, utilizing a hexadecimal keyboard. ASYNC and SYNC protocols. Communicates in ASCII, BAUDOT, EBCDIC, HEX, and SELECTRIC. Ideal for testing terminals.

HEWLETT PACKARD
1008A TEST MOBILE.....$ 475.00
1122A PROBE POWER SUPPLY.....$ 675.00
11473A BALANCING TRANSFORMER.....$ 335.00
73 ohms unbalanced to 600 ohms balanced. 20 Hz to 50 kHz. BNC(F) unbalanced to WECO 310 balanced.
11474A BALANCING TRANSFORMER.....$ 335.00
75 ohms unbalanced to 135 ohms balanced. 2 kHz to 2 MHz. BNC(F), unbalanced to WECO 241, balanced.
11475A BALANCING TRANSFORMER.....$ 315.00
75 ohms unbalanced to 150 ohms balanced. 2 kHz to 2 MHz. BNC(F), unbalanced to Siemens 9-REZ; STP-GAC.
11476A BALANCING TRANSFORMER.....$ 335.00
75 ohms unbalanced to 124 ohms balanced. 5 kHz to 5 MHz. BNC(F), unbalanced to WECO 408A balanced.
18110A LAB PROBE AND CALIBRATOR MODULE.....$ 1,325.00
1811A SAMPLING PLUG-IN.....$ 1,575.00
Provides 18 GHz, dual-channel, feed through sampling in 180-series scopes.
1915A OUTPUT AMPLIFIER PLUG-IN.....$ 1,300.00
Programmable parameters: Width (15-40 nsec), transistion (7 nsec to 100 µsec), Amplitude (0.05-1 A, 1.25-25 V) Offset (0-60 mA, 0 1.5 V).
2671G GRAPHIC PLOTTER.....$ 1,150.00
90 dots/inch raster capability; full 128 US ASCII. Rimon or extension and line drawing charactor sets.
3336B SYNTHESIZER/SIGNAL GENERATOR.....$ 3,675.00
Outputs of 10 Hz to 20 MHz (75 ohms unbalanced), 10 kHz to 10 MHz (124 ohms balanced), 10 kHz to 2 MHz (135 ohms balanced) and 200 Hz to 109 kHz (600 ohms balanced). Range of -72.99 to +7.00 dBm (75 and 600 ohms), -78.23 to +1.76 dBm (124 and 135 ohms). North American (Bell) configured. HP-IB Controllable.

800-527-4642 TUCKER ELECTRONICS COMPANY 214-348-8800

HEWLETT PACKARD

333A DISTORTION ANALYZER.....$ 1,400.00
5 Hz to 600 kHz. Measures to 0.1% fs distortion.

334A DISTORTION ANALYZER.....$ 1,500.00
5 Hz to 600 kHz. Measures to 0.1% fs distortion.

339A DISTORTION MEASUREMENT SET.....$ 2,450.00
10 Hz to 110 kHz. Harmonics to 330 kHz. Auto THD to 0.0018%. Measures to 0.01% fs distortion.

3581C SELECTIVE VOLTMETER.....$ 4,500.00
30 V to 100 nV (linear), 30 dBV to -150 dBV (log). 5-digit readout. Adjustable scan widths and sweep times.

3722A NOISE GENERATOR.....$ 2,700.00
Uses digital techniques to synthesize binary and gaussian noise patterns.

3722A/001 NOISE GENERATOR.....$ 2,995.00
Synthesized digital (+/- 10 V) and Gaussian (3.16 V RMS) noise patterns. With zero moment option.

3782B ERROR DETECTOR.....$ 5,375.00
Measures error rate, error count, error seconds and error free seconds simultaneously over single gating period. HP-IP controllable. Bell Systems Configured.

4301 AC POWER SOURCE.....$ 1,050.00
0-130/260 V, 2 A at 125 V; 1 A at 250V. Regulation +/- 1%, Frequency range 40-2000 Hz.

4328A MILLIOHMMETER.....$ 1,175.00
0.001 ohm to 100 ohms, 20 micro ohms resolution.

4342A Q METER.....$ 3,100.00
Measures Q (5-1000), L (0.09 µh to 1.2 h), C (25-470 pF) and resonant frequency (22 kHz to 70 MHz).

436A POWER METER.....$ 2,380.00
100 kHz to 18 GHz range or -70 dBm (100 pW) to +35 dBm (3 W).

6102A POWER SUPPLY.....$ 400.00
0-40 VDC, 0.5 A, 0.001%. CV/CC. Metered.

6105A DUAL POWER SUPPLY.....$ 450.00
0-50 V, 0.8 A and 50-100 V, 0.4 A. Metered.

6112A POWER SUPPLY.....$ 750.00
0-40 V, 0-0.5 A. Regulation 0.001%. Metered.

6205A DUAL POWER SUPPLY.....$ 450.00
0-20 V, 0-0.6 A and 0-40 V, 0-0.3 A. regulation 0.01%.

6206B DUAL POWER SUPPLY.....$ 295.00
0-30 VDC, 0-1 A and 0-60 V, 0-0.5 A. Regulation 0.01%. Metered.

6286A POWER SUPPLY.....$ 750.00
0-20 V, 10 A. 0.01% regulation. CV/CC, metered.

6521A HV POWER SUPPLY.....$ 1,500.00
0-1000 V, 0-200 mA, regulation 0.005% (V), 2% (I). CV/CC. Metered.

652A TEST OSCILLATOR.....$ 1,400.00
10 Hz to 10 MHz, 3.16 V output into 50 ohms. 90-dB attenuator.

7562A LOG VOLTMETER/CONVERTER.....$ 1,400.00
80-dB single-channel; AC/DC modes, 1 mV to 100 V.

8444A TRACKING GENERATOR.....$ 3,195.00
Measures swept frequency response and provides a contant amplitude signal for frequency counter input.

8565A SPECTRUM ANALYZER.....$22,500.00
0.01-22 GHz with internal mixing. < -80 dBm sensitivity (14.5-18 GHz).

8601A SWEEP/GENERATOR.....$ 2,500.00
100 kHz to 110 MHz. +20-110 dBm output. Output in dBm or V RMS.

8620C SWEEP GENERATOR MAINFRAME.....$ 3,195.00
Select up to four separate bands and four sweep functions. Three markers available.

8620C/011 SWEEP GENERATOR MAINFRAME.....$ 3,950.00
Offers full sweep, marker sweep, CW/Δ F, and CW. Uses 86200 series plug-in. Has HP-IB interface.

8640B SIGNAL GENERATOR.....$ 8,000.00
0.5 to 512 MHz, +19 to -145 dBm output. Calibrated and metered AM, FM, and pulse modulation.

8654B SIGNAL GENERATOR.....$ 3,500.00
10-520 MHz, +10 to -130 dBm output. Calibrated FM.

8656A SIGNAL GENERATOR.....$ 5,700.00
100 kHz to 990 MHz, 100 and 250 MHz resolution. 50 MHz timebase with +/- 2 ppm/year aging rate. Leveled output +13 to -127 dBm. AM/FM, HP-IB.

8903A AUDIO ANALYZER.....$ 5,295.00
Measures distortion, SINAD, s/n ratio, frequency (20 Hz to 150 kHz), and AC/DC level voltage.

K422A WAVEGUIDE CRYSTAL DETECTOR.....$ 550.00
18-26.5 GHz, +/- 2 dB response, 100 mW power.

KEPCO

ATE55-2M POWER SUPPLY.....$ 600.00
0-55 V, 2 A. 0.001% regulation. CV/CC, metered.

BOP72-1.5M POWER SUPPLY.....$ 1,495.00
0 to +/- 100 V, 1.5 A. 0.001%. CV/CC, metered.

JQE100-1MHS POWER SUPPLY.....$ 525.00
0-100 V, 1 A. Metered.

KROHN-HITE

3343R VARIABLE FILTER.....$ 1,500.00
Dual-channel unit. Acts as high-pass, low-pass, band-pass, or band-reject. 0.1 Hz to 99.9 kHz.

3550 FILTER.....$ 750.00
Band-pass, band-reject, low-pass, or high-pass operation. Cutoff frequency adjustable 2 Hz to 200 kHz.

DCA50 POWER AMPLIFIER.....$ 900.00
DC-500 kHz, 50 W output. 0.3% harmonic distortion, +/- 1 dB response.

150B MICROVOLT-AMMETER.....$ 800.00
Measures 300 nV to 1 V, and 3x10 to the -10th to 3x10 to the 3rd Amps. 2% accuracy.

LAMBDA

LE102M POWER SUPPLY.....$ 395.00
0-36 V, 5 A, 0.05% regulation. CV/CC, metered.

LE105M POWER SUPPLY.....$ 275.00
0-18 V, 0-8 A. Metered.

LE106FM POWER SUPPLY.....$ 550.00
0-18 V, 0-15 A. CV/CC, metered.

LK361FMOV POWER SUPPLY.....$ 1,995.00
0-36 V, 30-48 A. 1 mV regulation.

LEADER

LFM39A WOW/FLUTTER METER.....$ 890.00
Factory NEW Unit. 3 and 3.15 kHz frequency input. Measures wow/flutter to 0.0033% and drift to 0.25%.

LFR5600 AF RESPONSE RECORDER.....$ 2,595.00
Factory NEW Unit. Contains audio sweep oscillator, level meter, and chart recorder. Produces response curves 20 Hz to 30 kHz, +/- 0.5 dB.

LSG231 FM SIGNAL GENERATOR.....$ 420.00
Factory NEW Unit. Provides all signals required for testing troubleshooting and aligning FM multiplex receivers and tuners.

MICOM (3M CORP.)

8155A FLUTTER METER.....$ 995.00
0.5-200 Hz; measurements to 0.03%.

NARDA

4202B10 BROADBAND COUPLER.....$ 375.00
1-12.4 GHz, 10 dB coupling, 12 dB directivity. SMA(F) connectors.

4572B PHASE TRIMMER.....$ 155.00
3-18 GHz. Phase shift adjustment range 2 degrees at 3 GHz > 20 degrees at 18 GHz. SMA(M/F) connectors.

9535C SWEEP/SIGNAL GENERATOR.....$12,500.00
Programmable frequency and power. 1-18.5 GHz range, 5 mW output, RF leveled. Sweep times from 0.01-100 sec. Provides modulation, internal AM square wave and external pulse AM.

18500-32 RF PLUG-IN.....$ 3,500.00
1.9-2.35 GHz, 4 kW. Use in Narda 18500 RF Pulser.

PENN AIRBORNE PRODUCTS

MIS10412-5 100-GIGOHM STANDARD.....$ 300.00

MIS10412-6 1-TEROHM STANDARD.....$ 250.00

MIS10412-7 10-TEROHM STANDARD.....$ 250.00

PRINCETON APPLIED RESEARCH

100 CORRELATOR.....$ 3,450.00
Performs computation of cross correlation or auto correlation. Input frequency DC-300 kHz. 100 delay point with total delay range of 100 µsec to 1 sec.

JB5 LOCK-IN AMPLIFIER.....$ 1,275.00
1.5 Hz to 150 kHz, continuously tunable. 6 or 12 dB/octave roll-off.

POWER DESIGNS

3650S DC POWER SOURCE.....$ 395.00
0-36 V, 0-5 A. Current limited.

RF COMMUNICATIONS

808 SIGNAL GENERATOR.....$ 2,700.00
50 kHz to 80 MHz (1-kHz steps with with vernier to 1 Hz). Accuracy 5 parts in 10 to the ninth per day. Output of 0.1 µV to 10 V. AM/FM. Programmable.

**P.O. BOX 461966 GARLAND TX 75046 TELEX 79-1726**

RADIOMETER ELECTRONICS

101-03 SIGNAL GENERATOR.....$ 4,350.00
0.15-30 MHz and 86-130 MHz bands.

104 SYNTHESIZED SIGNAL GENERATOR.....$ 8,995.00
0.15-30 MHz and 86-130 MHz bands.

501 PROGRAMMABLE STEREO GENERATOR.....$ 3,995.00
Stereo modes L & R, L = R, L = -R, L, R. Separation > 65 dB and < 0.02 distortion.

901 MEMORY KEYBOARD.....$ 895.00
Use with models 104 and 501.

SMG40 STEREO GENERATOR.....$ 2,195.00
Pushbutton functions include L & R, L = R, L = -R, L, R, Pilot ON/OFF, Pre-emphasis ON/OFF, and Frequency (built-in audio oscillator).

SAUNDERS

100HF CRYSTAL IMPEDANCE METER.....$ 795.00
Measures quartz crystal static and motional parameters.

110HF CRYSTAL TEST OSCILLATOR.....$ 795.00
Measures device parameters in a series resonant mode.

SCIENTIFIC-ATLANTA

1710 PORTABLE RECEIVER.....$ 5,000.00
940 MHz to 40 GHz range.

STODDART

NM25T RECEIVER.....$ 7,500.00
150 kHz to 32 MHz range.

SORENSON

1061 HV POWER SUPPLY.....$ 2,500.00
0-60 kV, 0-10 mA.

DCR10-170B POWER SUPPLY.....$ 1,275.00
0-10 V, 170 A. 0.1% regulation. CV/CC, metered.

DCR80-30A POWER SUPPLY.....$ 1,500.00
0-80 V, 0-30 A. CV/CC, metered.

SRL40-12 POWER SUPPLY.....$ 795.00
0-40 V, 12 A. 0.01% regulation. CV/CC, metered.

SRL40-25 POWER SUPLY.....$ 1,200.00
0-40 V, 25 A. 0.01% regulation. CV/CC, metered.

TRANSISTOR DEVICES

DLR50-15-150A ELECTRICAL LOAD.....$ 475.00
0-50 V constant voltage, 0-3 A and 0-15 A constant current, 0-0.5 A/V and 0-3 A/V resistance ranges.

TEKTRONIX

GENERATOR PACKAGE SYSTEM.....$ 2,350.00
Consists of Tek 106 Squarewave Generator, 184 Time Mark Generator, 191 Signal Generator, and 067-0502-01 Calibration Fixture. Call a Tucker Sales Engineer for complete specifications.

2101 5-NSEC PULSE GENERATOR.....$ 600.00
+/- 10 V output. Period is 40 nsec to 400 msec. Rep rates 2.5 Hz to 25 MHz.

2215 PORTABLE OSCILLOSCOPE.....$ 1,150.00
Dual-trace, delayed-sweep. 60 MHz; 2 mV/div.

434 STORAGE OSCILLOSCOPE.....$ 3,700.00
Dual-trace, 25 MHz; full or split screen storage.

465B/DM44 OSCILLOSCOPE.....$ 2,650.00
DC-100 MHz, deflection 5 mV/div to 5 V/div. Sweep rate to 1 nsec/div with x10 magnifier. DM44 is Differential Time/DMM option.

TEKTRONIX

475A 250-MHZ OSCILLOSCOPE.....$ 3,475.00
Dual-trace; 2 mV/div; 1 nsec/div sweep rate.

485 OSCILLOSCOPE.....$ 6,200.00
350 MHz; 5 mV/div; 1 nsec/div sweep rate.

491 SPECTRUM ANALYZER.....$ 7,500.00
10 MHz to 40 GHz. Sensitivity -100 dBm or better.

492/02 PORTABLE SPECTRUM ANALYZER.....$ P.U.R.
50 kHz to 21 GHz standard, to 140 GHz with external mixers (not supplied). Frequency calibrated to 230 GHz. Reference level range -123 dBm to +40 dBm. Option 02 adds digital storage. Other options available upon request.

492/01/02 PORTABLE SPECTRUM ANALYZER.....$18,500.00
Same unit as 492/02 but with option 01 Internal Preselection added. Other options available upon request.

507 HIGH VOLTAGE SURGE SCOPE.....$ 4,500.00
50 V/cm to 500 V/cm, calibrated sweep 20 nsec to 50 µsec/cm.

577/D1 STORAGE CURVE TRACER.....$ 5,100.00
Allows characteristic curve of two devices to be overlaid.

177 CURVE TRACER TEST FIXTURE.....$ 995.00
Sold only with Tek 577 Curve Tracer.

7633 OSCILLOSCOPE.....$ 6,000.00
DC-100 MHz, Top writing speed of 1000 cm/sec.

7A22 DIFFERENTIAL PLUG-IN.....$ 1,125.00
Use with 7000-series oscilloscopes. DC-1 MHz, delection factor 10 µV to 10 V/div.

7T11 SAMPLING TIMEBASE PLUG-IN.....$ 3,600.00
For 7000-series scopes. Equivalent-time and real-time horizontal deflection; single and dual trace sampling. Time base 10 psec to 5 msec/div.

7D12 A-D CONVERTER.....$ 1,175.00
Mainframe unit only. Use with M1, M2, M3 modules to make most DVM measurements.

M1 DMM MODULE.....$21,500.00
Use with model 7D12. 0-1 kV (4 ranges); 0-20 Megohms (6 ranges); -55 degrees C to +150 degrees C (1 range).

M2 SAMPLE/HOLD MODULE.....$ 945.00
Use with 7D12. 25 MHz bandwidth. 1 mV resolution. 0-2 V and 0-20 V input range.

M3 TRUE RMS VOLTS MODULE.....$ 575.00
Use with 7D12 A-D Converter Plug-In. 40 Hz to 100 kHz. Measures up to 1 kV peak while floating input connectors.

TRYGON

M7C60-30 OV POWER SUPPLY.....$ 1,300.00
0-60 VDC, 30 A, 0.005% regulation. CV/CC.

WAVETEK

3006 520-MHZ SIGNAL GENERATOR.....$ 3,895.00
7-digit readout, 100 Hz resolution. Accuracy of +/-0.001%. RF output of 13 to -137 dBm.

WILTRON

9041 TEST SET.....$ 1,495.00
Measures transmission level +12 dBm to -48 dBm. Echo return loss and singing point tests measurement range 50 dB of return loss to 10 dB of return gain on 2- and 4-wire circuits.

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TUCKER
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